REFINING • PETROCHEMICALS • NATURAL GASOLINE

Petroleum Refiner

FEBRUARY
1957

SPECIAL COMPUTER REPORT

How to Start on Your Problems
. . . p. 102

Next—Programming in One Step
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NEW METHOD

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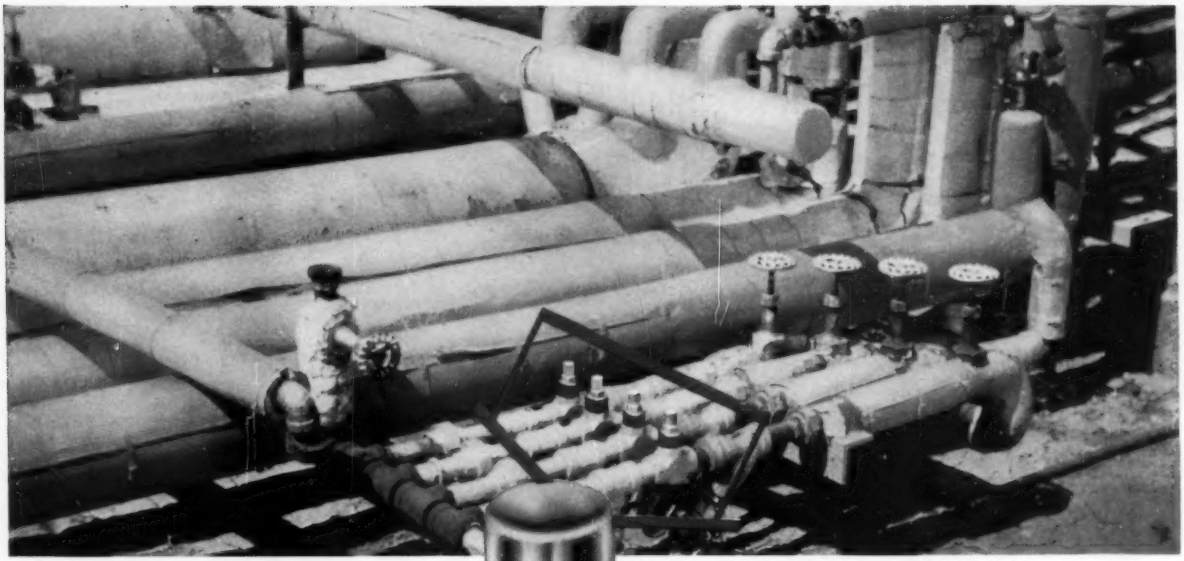
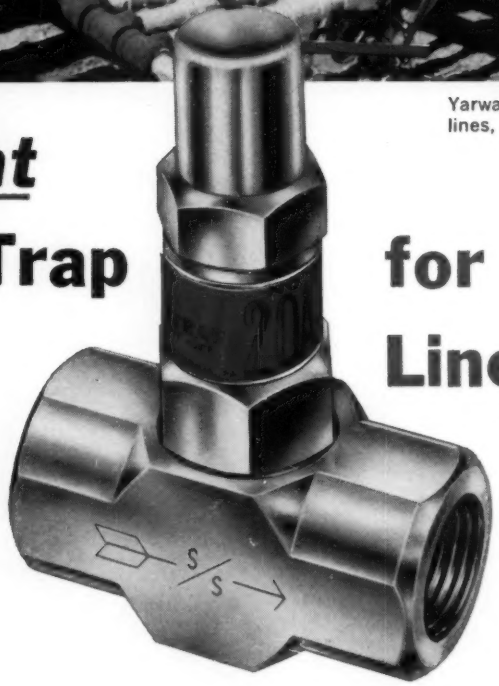
For a "Quick Look" at this issue, turn the page . .



Yarway Impulse Steam Traps on refinery tracer lines, discharging into a common header.

the *right* Steam Trap for Tracer Line Service



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Small size, light weight, stainless steel construction, only one moving part, maintenance of high even temperatures, and resistance to freeze-ups are distinctive Yarway Impulse Trap features. Well over a million Yarways proved by performance.

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Volume 36, No. 2 February, 1957

Petroleum Refiner

REFINING • PETROCHEMICALS • NATURAL GASOLINE

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A Quick Look at This Issue

These handy digests permit checking ☑ those articles you want to read first.

SPECIAL COMPUTER REPORT

☐ **Give Your Problems to the Computer . . .** Problems must be resolved into the language of the computer and personnel must be organized to handle the computer operations. For a timely discussion of these two facets of computer work, turn to **Page 102.**

☐ **Others Use Computers in These Ways . . .** Here is a survey of 25 major oil companies suggesting how computers will be used in our industry. To see how these applications may fit into your operations, turn to **Page 106.**

☐ **Tomorrow—Automatic Programming . . .** This peek into the future of digital computers reveals great advances in the field of automatic coding. See how the computer of the future will be asked to choose its own method of problem solution. **Page 109.**

☐ **Analog Computers Calculate Heat Transfer . . .** Here are the basic equations to solve natural convection problems, using an analog computer for some of the more common conditions. Now your problems can be solved graphically by referring to the charts starting on **Page 112.**

☐ **Programming the Analog Computer . . .** The d-c analog computers may be used to solve many applied mathematical problems. The principle work is done in programming. To learn how to simplify the analysis of various engineering problems and put them in a form that may be handled by the analog computer, turn to **Page 115.**

Please Turn Page ➔

A Quick Look at This Issue . . .

☐ **New Design for Process Heaters . . .** A simple principle of double-firing a vertically suspended tube bank gives remarkable efficiency. Although no radical departure from the conventional "box" heater, it is an entirely new design. Study this new arrangement and reevaluate some of your existing heaters. Turn to **Page 123.**

☐ **How to Design Perforated Trays . . .** A new method with new correlations and with a detailed sample calculation. This method was checked and proven on operating columns. You'll like the way the authors present this new design method. This is another one for your working notebook. See **Page 127.**

☐ **Improve Cat Cracker Feed . . .** Learn how cracked products are improved when the cracking feed is Unifined first. Data are given on gasoline yields and stability, sulfur and nitrogen concentrations, and octane ratings. Check your operations against those in the report starting on **Page 135.**

☐ **Abadan Refinery Continues Recovery . . .** This refinery is undergoing complete and selective overhaul. Throughput reaches 300,000 barrels daily. See how this refinery made its comeback. **Page 140.**

☐ **Cooling Water Treatment—a Review . . .** Use of cooling water brings along many associated problems. Some of these are: chemical scaling and corrosion, accumulation of living organisms, and the deterioration of the cooling tower lumber. See how to treat against these and other problems by turning to **Page 142.**

☐ **Polar Diagrams Speed Cooler-Condenser Design . . .** Here is a new method for the design of cooler-condensers. Tedious trial-and-error methods are replaced by a graphical procedure. A polar diagram is used to determine the gas-liquid interface conditions. This is for your design notebook. Turn to **Page 149.**

☐ **Automation Today—Part 8 . . .** To study automatic control, each component of the control loop must be examined. The source of errors and delays caused by the control valve or other final control element is discussed in this part of the series starting on **Page 155.**

☐ **Save Time and Get the Physical Properties of Your Petroleum Fractions by Nomograms . . .** It's a fact—the author has eight different properties on one single nomogram! You only need to know two properties, lay down your straight-edge on these two points and you've got the other six points. It's perfect for you working engineers—and you won't believe it until you see **Page 157.**

☐ **Easy Methods to Get Beam Deflection—Part 1 . . .** Here's a way to solve your beam deflection problems without using tedious algebraic methods. For complete details, turn to **Page 161.**

☐ **Extraction Results in a Hurry . . .** and get good results, too, with this nomogram by D. S. Davis. You'll save lots of time and energy. All you need is a straight edge and the nomogram on **Page 166.**

☐ **Save Time and Get Your K's With This Nomogram . . .** for any type of hydrocarbon over a wide range of pressures, temperatures and convergence pressures. And you will have the same accuracy as with any of the other more difficult current methods. The authors have really geared this one for the refining engineer—and you'll like it. Turn to **Page 167.**

☐ **Centrifugal Pump Packings & Seals—Part 2 . . .** Here's a way to determine the correct packing for the service application of your pump. Turn to **Page 173.**

☐ **How to Prevent Crude Oil Tank Fires . . .** The second article of this timely series covers the many aspects of crude oil tank fire prevention. For a thorough analysis of the proper use of flame arresters, prevention of boilover and slopover, safeguards against lightning ignition—as discussed by one of the nation's top fire experts, turn to **Page 100.**

☐ **Make Your Bonus Plan Pay . . .** An increasing number of refineries are adopting year-end bonus plans for key personnel. Reasons: Such plans boost employe morale and reduce absenteeism. For a bonus plan approach tailor-made to increase employe loyalty while saving countless tax dollars, turn to **Page 212.**

☐ **The Plight of Industrial Relations . . .** Industrial relations is so little understood by line management and employes that uncertainty, even hostility is shown toward its activities. In this candid report, a leading authority in the field outlines four reasons why industrial relations is becoming a scapegoat—and offers some excellent solutions to the problem. Turn to **Page 214.**

☐ **What the Courts Say About Trade Secrets . . .** Employers' trust in employes regarding trade secrets may be breached in many strange ways. Here is a thought-provoking report on what the courts say about a variety of patent infringements ranging from rotary pumps to refinery stills. Turn to **Page 226.**

See Pages 91 and 92 for a Quick Look at 'news you need to know'

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PETROLEUM REFINER and The REFINERY CATALOG for the refining natural gasoline-petrochemical industry

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry

PIPE LINE INDUSTRY and The PIPE LINE COMPOSITE CATALOG (first edition to be issued in July, 1957) for the oil and gas pipe line industry.

Petroleum Refiner is indexed by Industrial Arts Index, Chemical Abstracts and by Engineering Index, Inc. Microfilm copies available through University Microfilms, Ann Arbor, Michigan.

Like Our New Dress?

WE THOUGHT we'd let it speak for itself. And it did!

Here we are talking about PETROLEUM REFINER's new front cover, which last month for the first time appeared sans advertisement. We could, as stated, have ballyhooed it in advance on this, Page 5 where we discuss various matters relating to magazine making. But we figured it would make sufficient impact without any help from this corner.

We think this is a forward step, one that our readers generally will appreciate. It costs, of course. Front cover space is in strong demand, and its price tag is high. But if the change better serves the reader, then that's some compensation. It serves PR too because in that not-to-be-dodged spot we can give hints as to the month's contents and in that way additional readers doubtless are attracted to articles of special interest.

Happy Birthday

THE SYNTHETIC RUBBER INDUSTRY, under private ownership, begins its second year soon. This brand-new industrial giant was born large and fully developed. The past year has witnessed events that prove the success of the independent management.

Production—More than 1 million tons of synthetic rubber was produced; this was in the face of a below-normal automobile year.

Nomenclature—Standard terms for the various types of synthetic rubbers and latices were developed and adopted by the industry. These are the ASTM Designations: D 1418-56 T, D 1419-56 T and D 1420-56 T.

Expansion—The largest expansion program the industry has ever known was begun. Both in the U. S. and overseas this expansion continues and in the face of lower natural rubber prices and plentiful supply.

We foresee a rosy future for this young industry. PETROLEUM REFINER's March Special Report on Synthetic Rubber will limelight its development, problems and possibilities.

Gain for Us All

COMMENT CAME our way recently when a reader wondered about the references to advertising which have appeared in this space during the past few months. That voluntary commentator, even as you and I, likely has a pretty good idea of advertising's role in the publication of a periodical of PETROLEUM REFINER's type. If he hasn't, then this remark by our publisher might be enlightening: "Do you suppose he realizes that without advertising his PR subscription rate would be more like $40 than $2 per year?"

Quick as a cat... Quiet as a mouse

CHAPMAN
Tilting Disc Check Valve

There, in a nutshell, is the story of a Chapman Tilting Disc Check Valve . . . quick as a cat, quiet as a mouse. It's designed that way. It's built that way . . . for fast, sure, quiet action. Or, in other words, it's yours for best performance at lowest long-range operating costs.

With a Chapman Tilting Disc Check Valve, there's no noise, no vibration, no fluttering. There's no banging or slamming with damage to system or valve. There's no scraping or wearing of disc and seat. Your head loss or flow resistance is kept at a minimum.

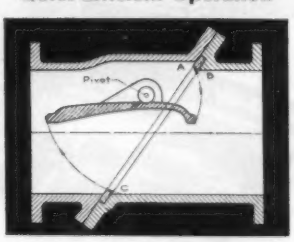
To put it briefly, with a Chapman Tilting Disc Check Valve, there's little or no maintenance even under severe operating conditions.

For Chapman Tilting Disc Check Valves in iron and steel . . . valves for handling fluids or gases under a wide range of pressures . . . valves for replacement or new piping systems . . . just check our Catalog 30-A. It's yours for the asking. Send for it now.

The CHAPMAN Valve Mfg. Company
INDIAN ORCHARD, MASSACHUSETTS

Never a Flutter, Never a Slam!

Designed and Built for Quiet Efficient Operation

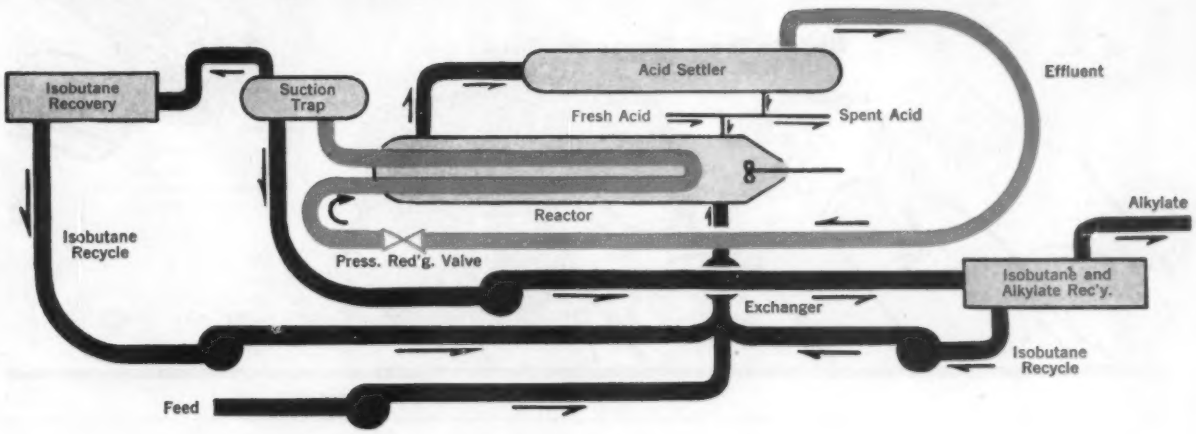


In open position, specially designed "airfoil" disc balances perfectly. No vibration. No flutter. When flow subsides, disc drops quickly and quietly to a tight closed position. No jarring. No slamming. No damage to system or valve. Note enlarged area around disc to insure low flow resistance.

For more data on advertised products, use Readers' Service Cards, last page.

LOW-COST alkylate FOR MOTOR OCTANE

effluent refrigeration



H_2SO_4 consumption—as low as 0.3 lb per gal of alkylate

EFFLUENT REFRIGERATION, the most important advance in alkylation technology in 15 years, now classifies alkylation as a most valuable process technique for production of the higher octanes. A substantially decreased acid consumption, higher yield of higher octane and a reduction in fractionation requirements for motor alkylate production are the major factors responsible for this most important process improvement.

An effluent refrigeration alkylation unit designed by Foster Wheeler is now being constructed for a major mid-western refiner. Capacity, 3,800 bbl per day of motor alkylate.

Flow description: Feed, mixed with recycle isobutane, enters reactor through heat exchanger. Thorough agitation with sulfuric acid, and high-isobutane ratio maintain optimum reaction conditions. Total reactor effluent separates in acid settler, acid returns to reactor. Hydrocarbon effluent from settler flows through pressure reduction valve into cooling coils in reactor maintaining predetermined temperature therein. Vapor and liquid separate in suction trap. Vapor, mainly isobutane, is recovered and returned to reactor. Liquid is pumped through heat exchanger to fractionation system where recycle isobutane and product alkylate are recovered. For further information write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

For more data on advertised products, use Readers' Service Cards, last page.

ALUNDUM* Catalyst Carriers and Supports

are proved aids to better, lower cost processing

Norton ALUNDUM catalyst carriers have excellent mechanical, thermal and chemical stability. They are crystalline in nature and are produced in two surface area types: Intermediate (5-70m²/gram) and Low (less than 1m²/gram).

The alumina content of the intermediate carriers is approximately 77%. These are subdivided into Types A, B and C, with varying characteristics. In the low surface area carriers, the alumina content ranges from 77% to 92%.

PHYSICAL PROPERTIES

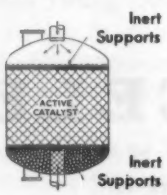
	Apparent Porosity	Water Absorption	Bulk Density	Vol. Bulk Density	Crystal Structure	Surface Area
Intermediate Surface Area Type A	45-50%	28-30%	.65-1.70 gr/cc	58 lbs/ft³ (Approx.)	Quartz, Alpha, Gamma Alumina — chiefly Gamma Alumina	60-70m²/gram
Type B	45-50%	28-30%	1.65-1.70 gr/cc	60 lbs/ft³ (Approx.)	Quartz, Alpha, Kappa, Delta Alumina	20-30m²/gram
Type C	45-50%	28-30%	1.65-1.70 gr/cc	62 lbs/ft³ (Approx.)	Alpha Alumina and Mullite	5-10m²/gram
Low Surface Area	10-50%	3-25%	1.90-3.15 gr/cc	65-80 lbs/ft³	Alpha Alumina and Mullite	Less than 1m²/gram

Some Of Many Applications

Suggested Applications For Intermediate Surface Carriers include catalytic reforming, dehydrogenation, dehydration, sulfuric acid manufacture, nitric acid manufacture and dessicants.

Low Surface Area Carriers are used in the processing of phthalic anhydride, maleic anhydride and ethylene oxide; also in protective atmospheres and synthetic gas generation.

Suspending Active Catalysts Effectively



In fixed bed convertors where it is necessary to suspend active catalysts at a given level, supports produced by Norton are used successfully. Made of dense, rugged, electrically fused materials these supports have great resistance to breakdown and have no chemically reactive effect on the processing.

Get More Facts

on how Norton catalyst carriers and supports can improve and economize your processing. On request, they can be prepared from other materials such as: CRYSTOLON* silicon carbide, MAGNORITE* fused magnesia, zirconium oxide, silica, etc. Call in your Norton Refractories Engineer or write, mentioning your requirements, to NORTON COMPANY, Refractories Division, 461 New Bond St., Worcester 6, Massachusetts.

NORTON

REFRACTORIES

Engineered... Rx ...Prescribed

Making better products... to make your products better

NORTON PRODUCTS:
Abrasives • Grinding Wheels
Grinding Machines • Refractories
BEHR-MANNING PRODUCTS:
Coated Abrasives • Sharpening Stones
Behr-cat Tapes

*Trade-Marks Reg. U.S. Pat. Off. and Foreign Countries

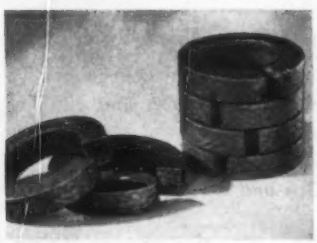
For more data on advertised products, use Readers' Service Cards, last page.

MORE OF THE GARLOCK **2,000**

Special Braiding Machines produce Garlock LATTICE-BRAID Packings. Designed and built for Garlock, these machines produce a pattern which cannot be made on ordinary braiders.

HOW GARLOCK LATTICE-BRAID* PACKINGS DIFFER

from Ordinary Braided Packing



Oil Industry

Centrifugal transfer pump alternately handling caustics, lime, acid and solvents at temperatures to 200° F. was repacked twice a week . . . shaft replaced twice a year. LATTICE-BRAID has given 10 months continuous service . . . saving over $100. already in materials alone.

The Garlock LATTICE-BRAID Packing is distinctly different . . . the result of many years of development and experimental work.

Special machines are required to manufacture the LATTICE-BRAID structure. And the superiority of LATTICE-BRAID packings is due to the unique braiding pattern which cannot be duplicated on ordinary braiding machines.

ADVANTAGES: unified structure gives greater strength; no disintegration; less gland adjustment; unusual flexibility.

LATTICE-BRAID is another important part of "the Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals to meet all your needs—the *only* complete line. That's why you get *unbiased* recommendations from your Garlock representative. Call him today or write for LATTICE-BRAID Folder AD-131.

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

**Registered Trade Mark*

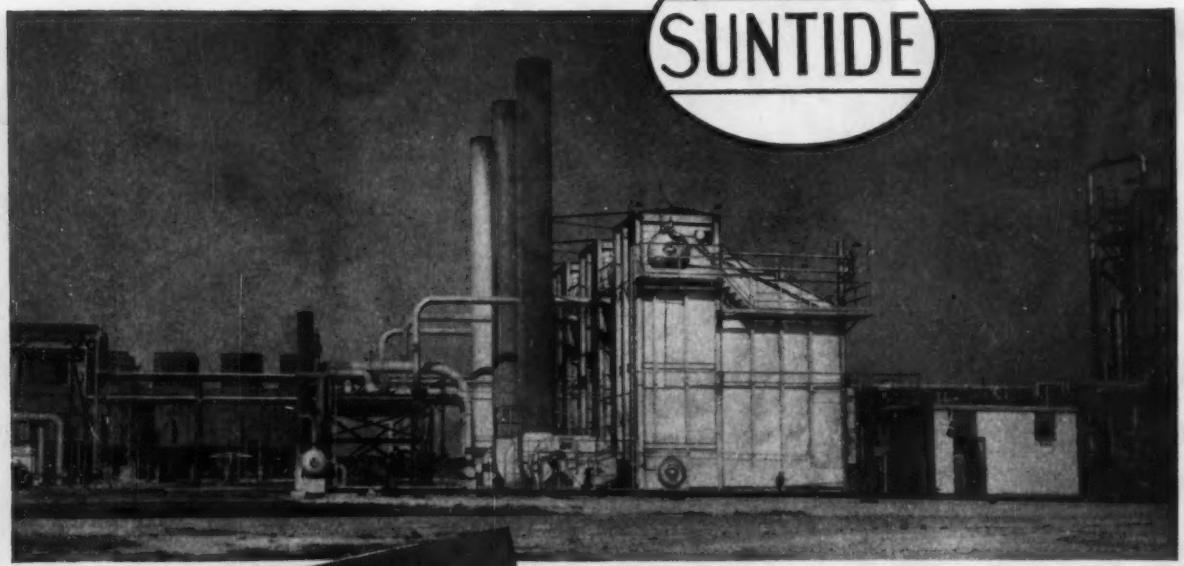
GARLOCK

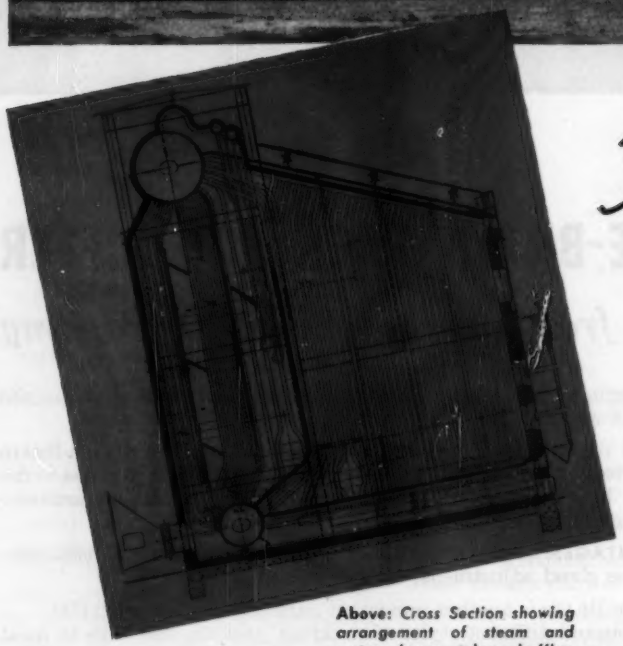
Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

Vogt STEAM GENERATORS

at **SUNTIDE REFINING COMPANY**
Viola, Texas

SUNTIDE





Above: Cross Section showing arrangement of steam and water drums, tubes, baffles, and furnace.

3 Units Installed
2 Units on Order

Principle Data Each Unit

- 85,000 pounds steam per hour capacity, designed for 500 lbs. S.W.P. and 625° F. total temperature.
- Water cooled furnace.
- Burners for Gas and Oil fuel.

Vogt offers a complete line of custom built and package type steam generators. Available in bent tube and straight tube designs for solid, liquid, or gaseous fuels burned singly or in combination.

Write for bulletins. Dept. 24A-BPR

OTHER VOGT PRODUCTS

Drop Forged Steel Valves, Fittings and Flanges—
Petroleum Refinery and Chemical Plant Equipment
Heat Exchangers
Ice Making and Refrigerating Equipment

HENRY VOGT MACHINE CO.
Box 1918, Louisville 1, Kentucky

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati

What *lead does to control corrosion*

in producing and storing Phosphoric Acid

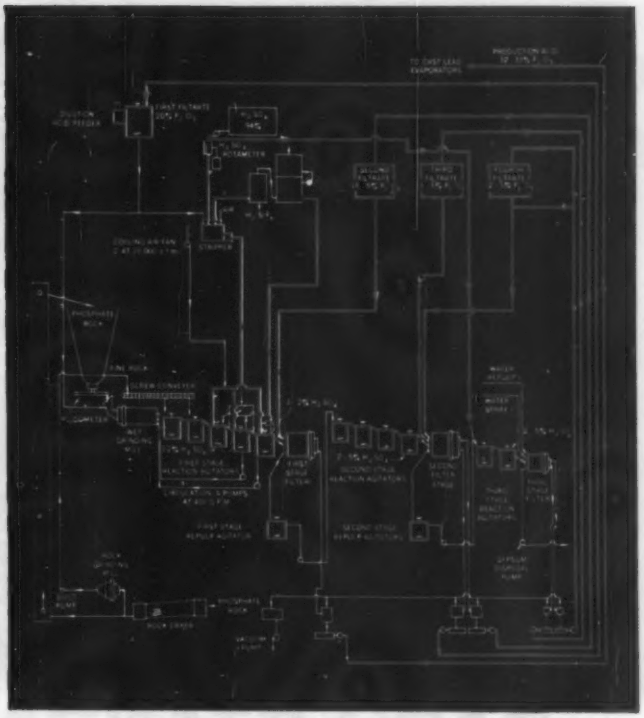
H_2SO_4 and P_2O_5 are a hungry pair.

They eat right into most metals. But *lead* takes the sharp edge off their hunger quickly.

With each of these chemicals, *lead* reacts on contact to form on the surface of the metal an insoluble and impervious film. This film stops further corrosion.

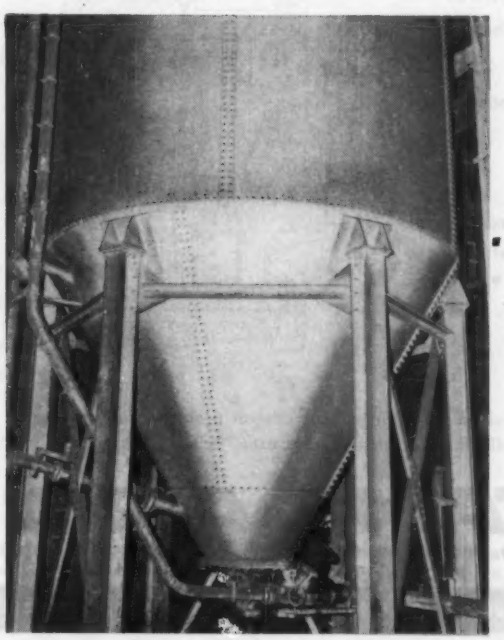
That's why *lead* has long been a "first choice" material in much of the equipment used for treating phosphate rock with sulfuric acid to produce phosphoric acid. It is used for lining vessels and tanks, in piping and pumps, in evaporator coils and for raking blades in agitators.

Recently new forms of cage-type sheet *lead* structures, new bonding and strap-lining methods, new constructions for high-temperature erosion-corrosion service and automatic stud welding techniques, have increased *lead's* usefulness . . . not only in phosphoric production but in many other applications.



What about *lead* for your own acid handling equipment . . . considered in the light of these new techniques! It's something to think about, and . . .

When you think of Lead . . .



think of National Lead Pressure Vessels

. . . lead-lined to last

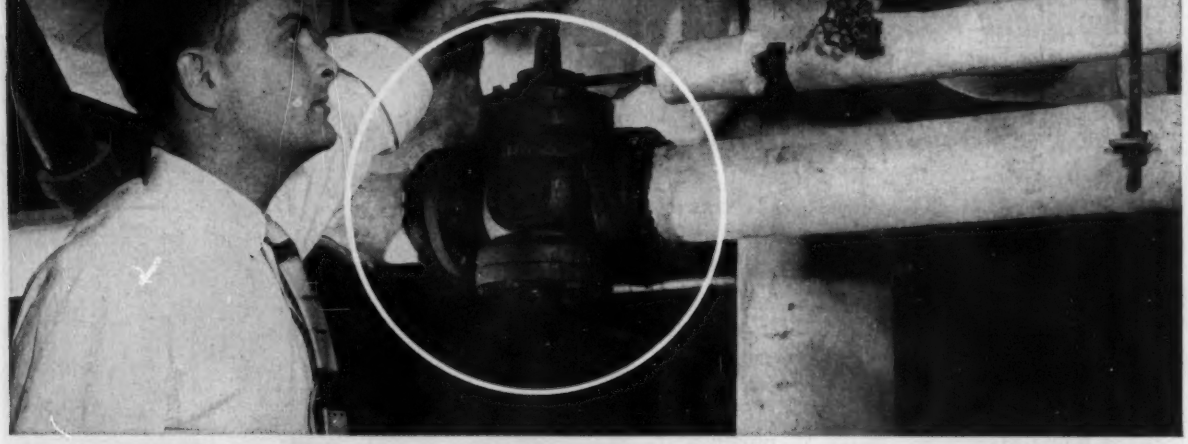
Today, National Lead weds *lead* to steel . . . not only in pipe (Tubond®) and fittings (United®) but in massive and complex process and storage and shipping vessels, as well. In this equipment, the union is stronger than the tensile strength of *lead*. Bonded lead linings minimize troubles from vibration and severe and rapid cyclic temperature and pressure changes which can result in blistering, buckling and cracking. Creep is virtually eliminated.

In view of this and other developments, you may want to review your position on *lead-lined* tanks, stills, scrubbers, filters, piping, valves and other corrosion resisting equipment. If so, contact National Lead Company, Lead Lined Products, 111 Broadway, New York 6, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

PROVEN PERFORMANCE

at A. E. STALEY Mfg. Co.

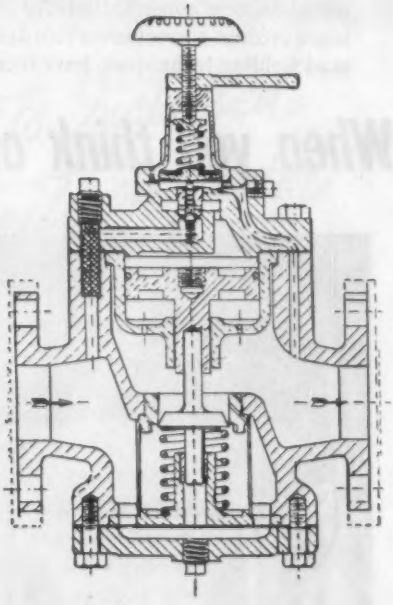


CASH STANDARD Type 44

Pressure Reducing and Regulating Valve for Steam Service

Sudden changes in the requirements for hot water in the employees' shower rooms at the **A. E. Staley** plant, Decatur, Ill., demand full capacity range operation of the regulating valve with precise control of downstream pressure.

In April of 1956, a CASH STANDARD Type 44 Steam Valve was installed in the line supplying steam to the heater. **Gerald Hammond,** instrument engineer at **Staley,** reports: "The CASH STANDARD Type 44 has given exceptionally good service—the kind of service we expect from all CASH STANDARD products. It has required no maintenance since installation eight months ago."



What's your control problem? Use this dependable steam valve.

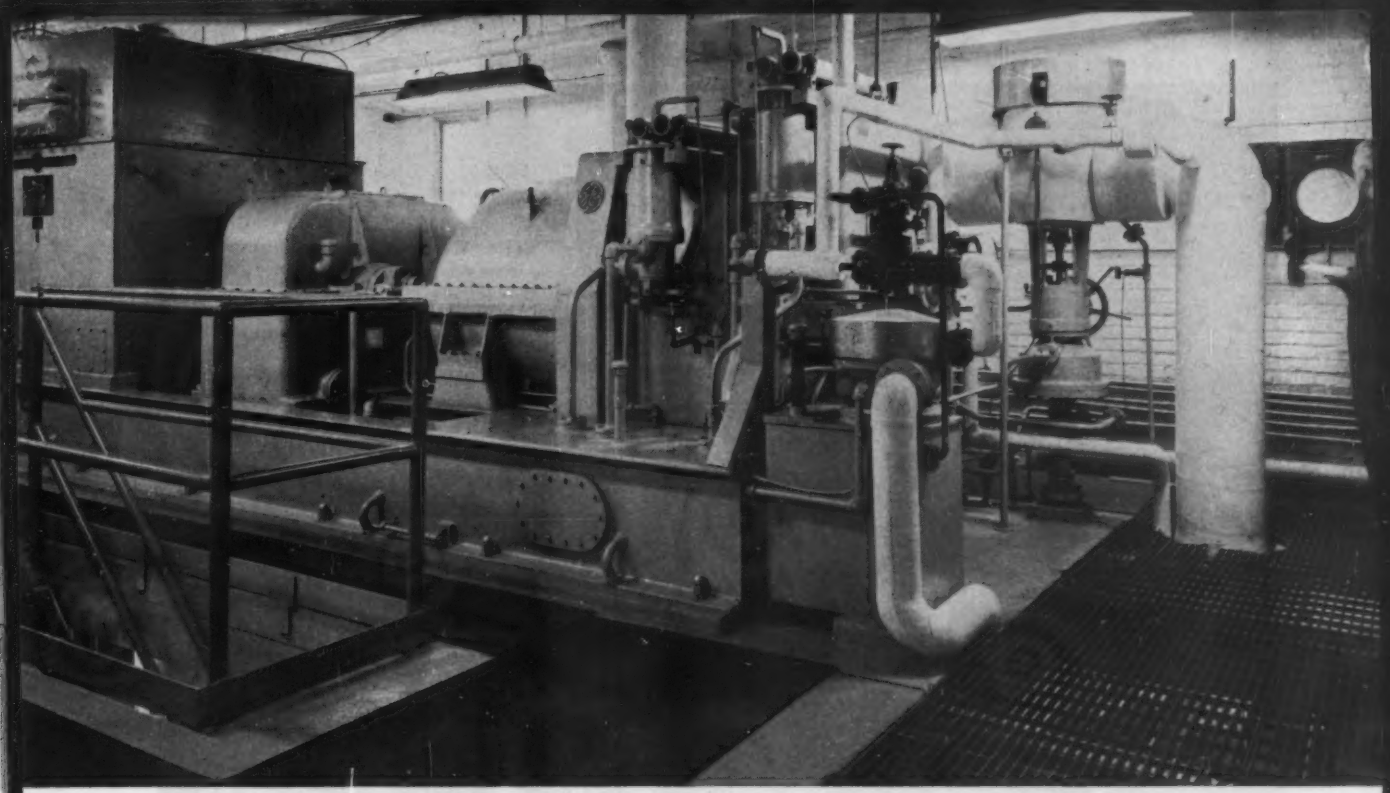
Built in Pilot and Main Valve Strainers • Internal Pilot-Operated, Piston-Actuated • Single Seat • Highly Sensitive, Responsive to Smallest Changes in Reduced Pressure • Maximum Inlet Pressure 250 PSI @ 400°F. • Delivery Pressure 5-250 PSI • Available with External Sensing Line • Sizes 2", 2½", 3", 4".

For an individual solution to your control problem, contact the CASH STANDARD specialist in your area, or write Dept. L.

CASH CS STANDARD

A. W. Cash Co. and Its Subsidiary, Cash Standard Stacon Corp.
P. O. Box 551, Decatur, Ill.

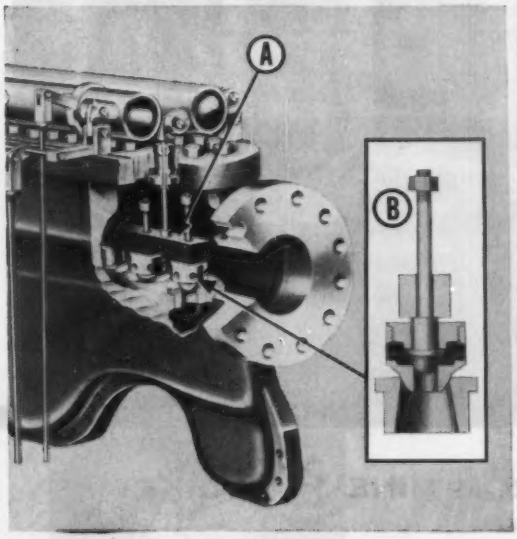
PRESSURE, HYDRAULIC, TEMPERATURE, PROCESS AND COMBUSTION CONTROLS



1500-kw General Electric steam turbine-generator installed at Foster Paper Company, Utica, New York.

General Electric's simplified valve gear offers more efficient turbine governing

DESIGN FEATURES PROVIDE CLOSE CONTROL, EASY MAINTENANCE



A. SIMPLIFIED BAR-LIFT arrangement of poppet-type valves has few parts, requires less maintenance.

B. DOUBLE-LIFT VALVES used on G-E high-speed turbines are a valve-within-a-valve arrangement. This means that the force required to open a valve is reduced allowing closer speed control over process operations.

*In Canada, contact Canadian General Electric, 107 Park St., Peterborough, Ont.

Here's another answer to requirements for safer, surer high-speed turbine operation. General Electric's simplified sectional valve gear mechanism offers more efficient governing and an improvement in heat-cycle efficiency.

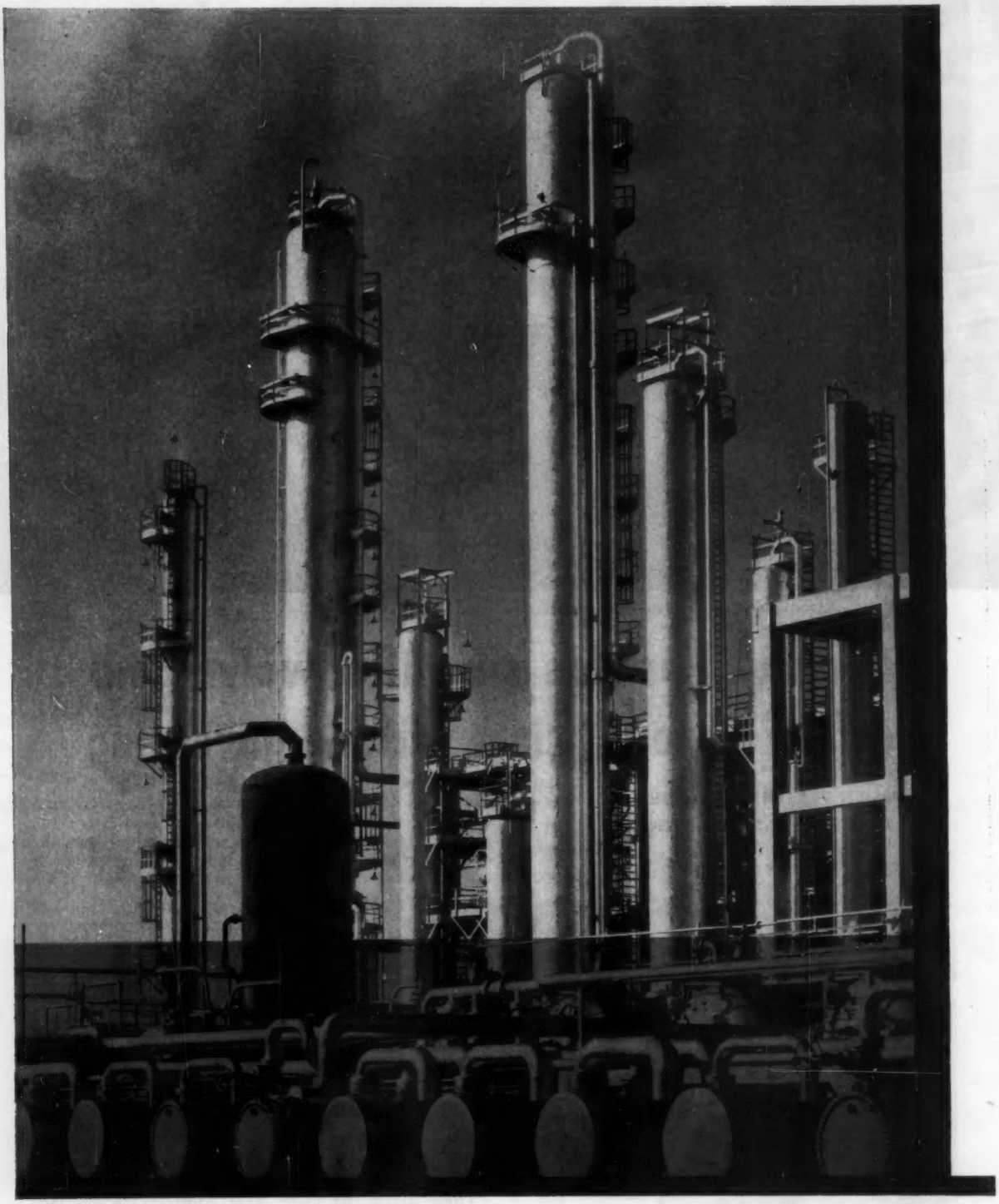
SIMPLICITY OF DESIGN and easy maintenance are provided by a bar-lift arrangement of poppet-type valves, each of which supplies steam to part of the nozzle area. As less flow is required, these valves are successively closed to keep the nozzle area in proportion to the steam required. The result is more accurate control of steam flow and reduced throttling losses.

INCREASED GOVERNING EFFICIENCY is also provided by the best combination of valves and seats. Single- or double-poppet valves and angle or venturi seats are available to meet your specific requirements. Nozzle area can then be matched with the proper valve combination to obtain uniform horsepower gradient.

These simplified valve gear components are still another example of the sound engineering built into every General Electric high-speed turbine. For complete information, contact your nearest General Electric Apparatus Sales Office*, or write for bulletin GEA-6232, General Electric Company, Section 241-9, Schenectady, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC



FIRST FOR LASTING QUALITY—FROM MINE TO MARKET!

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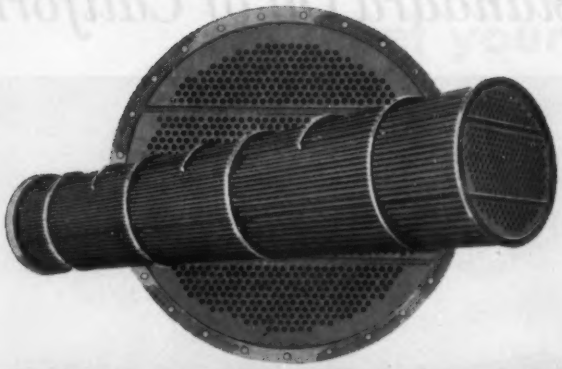

For dependable "on-stream" performance...
retube your exchangers with

PHELPS DODGE HEAT EXCHANGER TUBES!

Wide selection of copper-base alloys for every type of application—including bi-metal combinations.

Complete warehouse stocks maintained at Houston, Texas; Tulsa, Okla.; Los Angeles, Cal.; Chicago, Ill.; and Bayway, N. J.

Expert assistance in solving your tube corrosion problems.

Specify Phelps Dodge... One of the largest suppliers of tubes to manufacturers of heat exchangers!

PHELPS DODGE COPPER PRODUCTS CORPORATION

SALES OFFICES: Atlanta, Birmingham, Ala., Boston, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Fort Wayne, Greensboro, N. C., Houston, Jacksonville, Kansas City, Mo., Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Washington, D. C.

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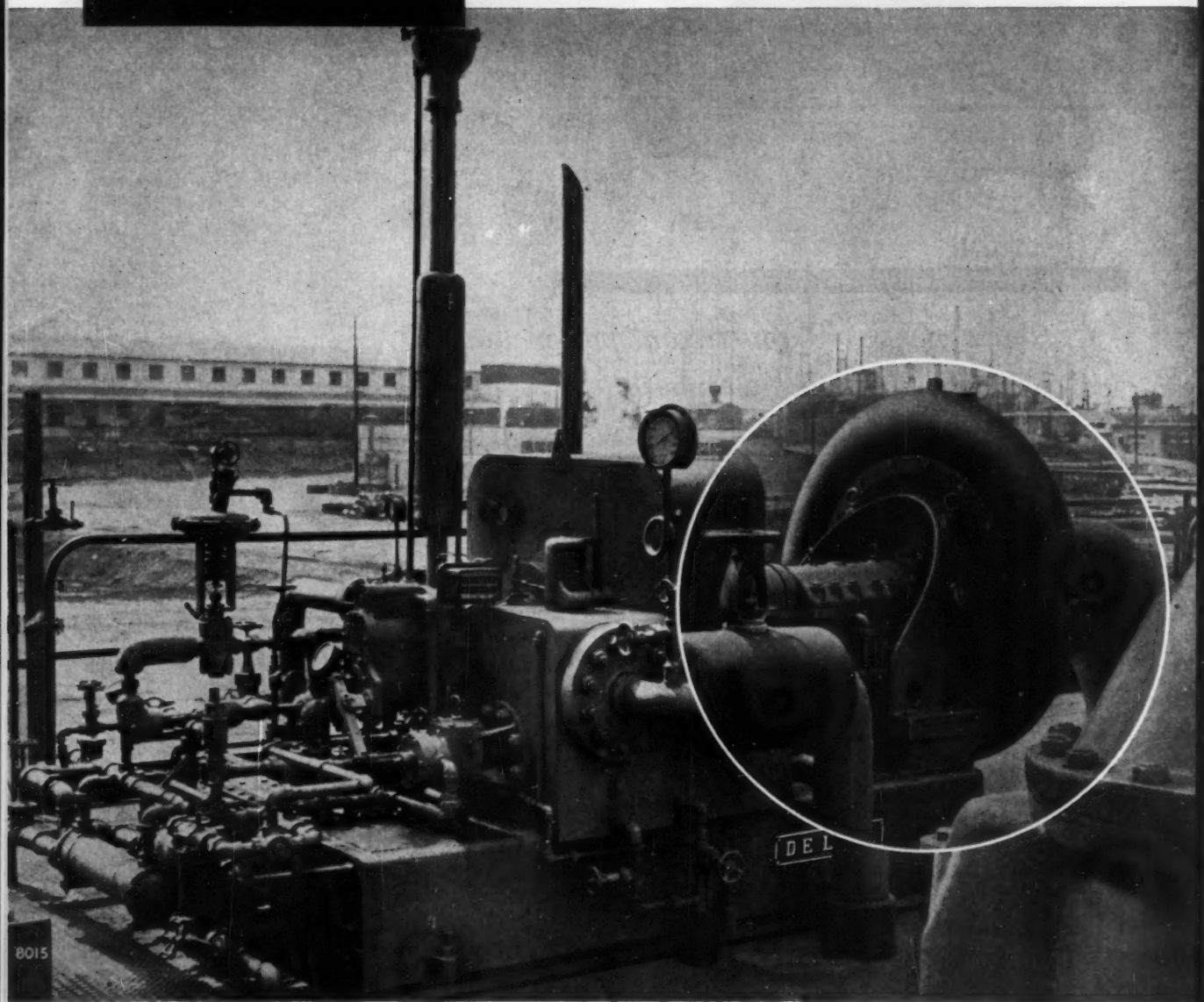
DE LAVAL
CENTRIFUGAL
BLOWER

controls air in cat cracker at Standard Oil of California



This De Laval centrifugal blower, selected by the Fluor Corporation, is on stream at the Standard Oil Company of California's new cat cracker in El Segundo. For control air service, this blower delivers 9,500 cfm; inlet pressure is 15.4 psig and discharge pressure 19.4 psig. The blower is driven by a De Laval 220 brake horsepower MCP Turbine operating at 800 psig with a temperature of 650 F; it has all labyrinth shaft packing for high back pressure service.

In addition to single stage designs, De Laval makes a complete line of equipment for all refinery services, including multi-stage compressors driven by De Laval multi-stage turbines for condensing, non-condensing and automatic extraction applications.

Send for new Bulletin 0504

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY
811 Nottingham Way, Trenton 2, New Jersey

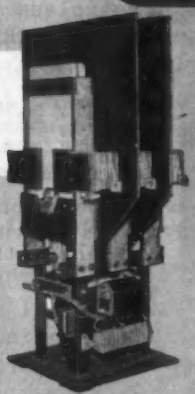
DL 288

CHOICE of CONTACTORS

to meet your specific needs

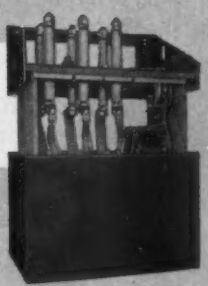
ALLIS-CHALMERS
Type H Starters
FOR 2300 TO 5000 VOLT MOTORS

Allis-Chalmers Type H Starters may be equipped with either air-break or oil-immersed contactors —installed in the same sized space.



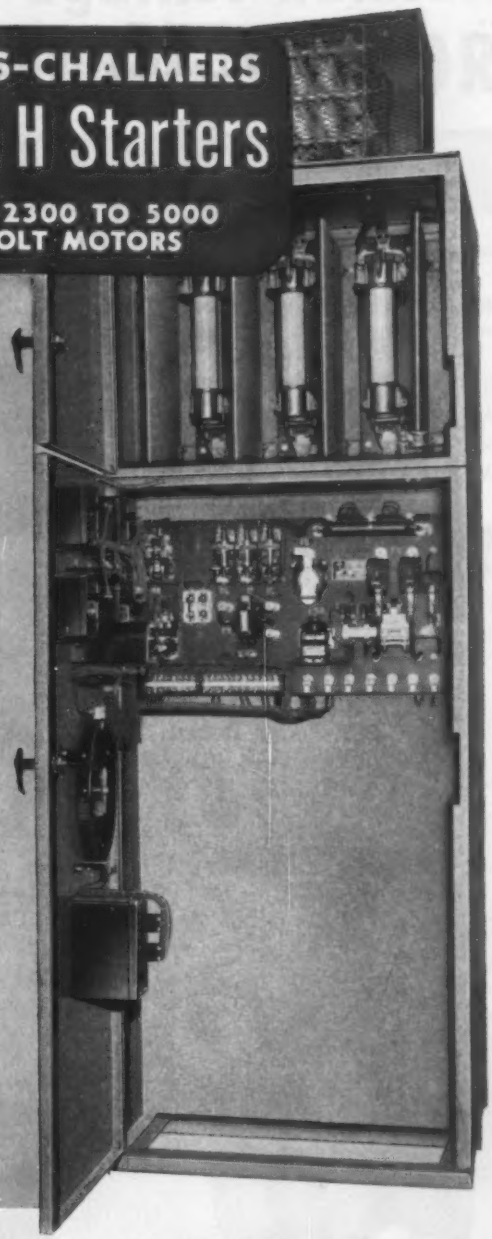
AIR

Designed for top performance on the rough-tough jobs. Advantage of contacts operating in air include long contact life, reduced fire hazard, easy maintenance. Double-break contacts, vertical action and dual blowouts provide long, dependable operation. Design simplicity makes contactor particularly adaptable for applications requiring frequent starting, inching, reversing, or dynamic braking.



OIL

Meets operating demands of semi-hazardous locations. Contactor operates under oil to prevent sparks from igniting atmosphere and to protect mechanism from corrosion. Contactor is time-proved clapper type. Self-cleaning, rolling-wiping action extends contact life. Self-aligning E-type magnet provides perfect armature seating . . . quiet, maintenance-free operation.



YOU GET MORE...

Allis-Chalmers offers help on specific control application problems. Call your Allis-Chalmers representative. His recommendations are backed by Allis-Chalmers engineering departments . . . by the experience gained in solving thousands of control problems . . . by complete research and testing facilities.

For complete information on the Type H starter, write for Bulletin 14B6410B — Allis-Chalmers, General Products Div., Milwaukee 1, Wis.

ALLIS-CHALMERS

A-4976

For more data on advertised products, use Readers' Service Cards, last page.

Inside Story on POWELL PETROLEUM VALVES

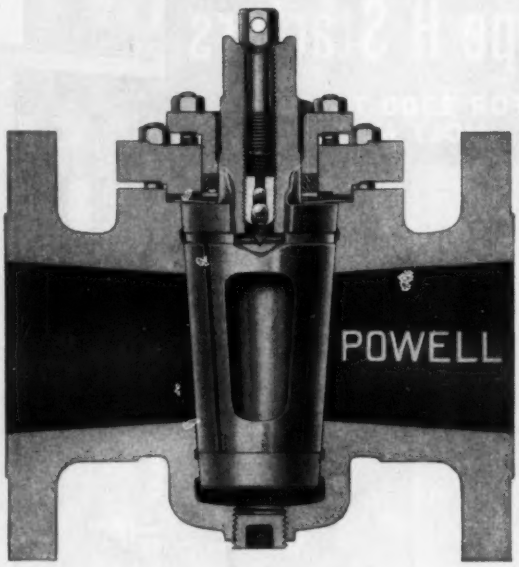


FIG. 2201 (Sectional) -- 200-Pound W.O.G. Semi-Steel Lubricated Plug Valve

Petroleum valves may appear to be alike on the outside. But inside -- in materials, in design, in manufacture -- there can be a world of difference. And the inside story on Powell Petroleum Valves is that every valve has PERFORMANCE VERIFIED.

Only the finest materials are used in Powell Petroleum Valves, and painstaking quality control is rigidly enforced through each step of manufacture

As a final step in manufacture, every Powell Petroleum Valve is subjected to an ACTUAL LINE TEST. Because of Powell's quality control, valve failure is practically unknown. Records from the world over prove it.

Valve users who want one source of supply for Lubricated Plug as well as all types of bronze, iron, steel and corrosion-resistant valves will want full details on Powell Petroleum Valves

Available through distributors in principal cities. If none is located near you -- or if you need help on valve problems -- write direct to The Wm. Powell Company, Cincinnati 22, Ohio.

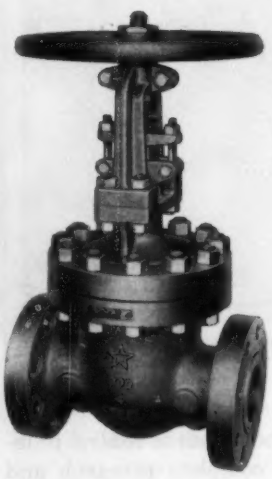


FIG. 9003 -- 900-Pound Steel O.S. and Y. Gate Valve Bolted Flanged Bonnet

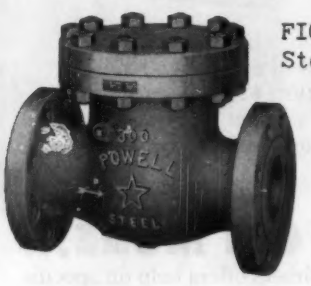


FIG. 3061 -- 300-Pound Steel Swing Check Valve

PERFORMANCE PV VERIFIED

The Wm. Powell Company, Cincinnati 22, Ohio . . . 111th YEAR

POWELL VALVES

BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES

for cooling tower application...

There's MORE protection against humidity in Allis-Chalmers MOTORS

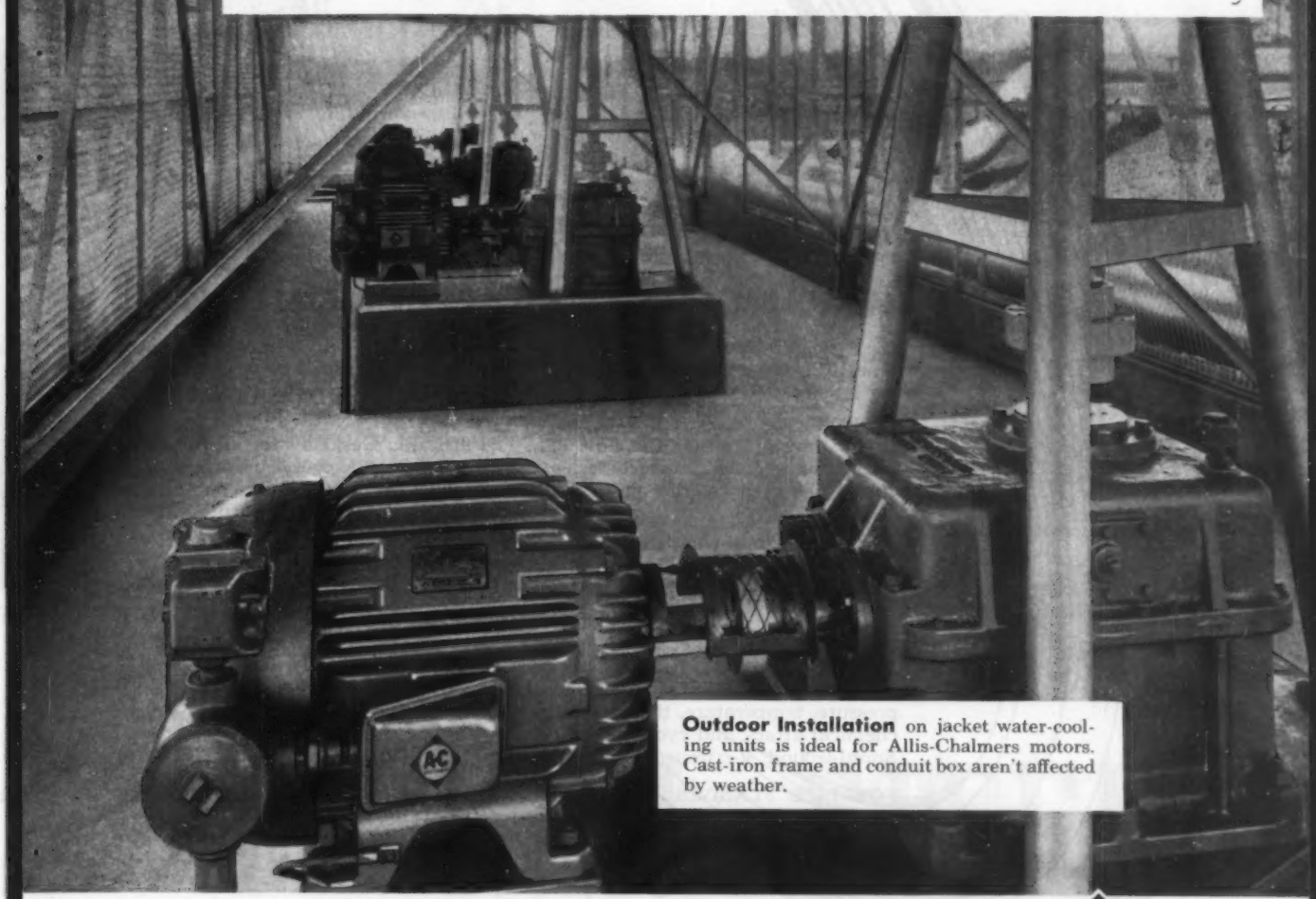
The ultimate in protection against high humidity — major cause of cooling tower motor failure — is provided tower builders and users in Allis-Chalmers TEFC motors. Here's why:

1. **Moisture drainage** — Drain plug can be removed to eliminate condensed moisture in the motor. (Particularly helpful in intermittent operations where condensation is more likely.)

2. **Extra-insulated stator** — Several applications of special insulating varnish plus repeated baking keep humidity out . . . give the long electrical life you need.

3. **Weather-protected bearings** — Rotating seal, turning in close running clearances, guards against entry of water.

Find out more about the "MORE" in Allis-Chalmers motors by contacting your nearby A-C sales office or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis.



Outdoor Installation on jacket water-cooling units is ideal for Allis-Chalmers motors. Cast-iron frame and conduit box aren't affected by weather.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5183

MAKING GASKET SELECTION EXACT

It's easy to select the right Flexitallic Spiral-Wound Gasket for known sealing requirements because —

(1) Gasket designs have been so developed that the bolt load for a given pressure series is balanced by the gasket reaction;

(2) Structural characteristics compensate for variations in operating conditions.

For 45 years, devoted exclusively to Spiral-Wound Gasket construction, Flexitallic Gaskets have been designed to meet specific conditions of pressure, temperature, thermal shock, chemical attack and cyclic operation. Spiral-wound V-crimped plies of required metal with alternating plies of proper filler result in a gasket with compression characteristics like those of a pre-calibrated spring.

Flexitallic Gaskets—for all pressure/temperature ranges from vacuum to 10,000 lbs. from extreme sub-zero to 2000°F. For all standard joint assemblies. In four thicknesses: .125", .175", .250", .285".

FLEXITALLIC GASKET CO.
8th & Bailey Sts., Camden 2, N. J.
Representatives in principal cities

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Flexitallic is a registered trade name. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue*—it's our exclusive blue-dyed Canadian asbestos filler.

How to make your automatic heat-treating and hardening even more automatic

...at no extra cost

FAST, continuous operation is the key to profitable automatic forging production lines. Especially in high speed heat-treating and hardening operations. They're extremely sensitive to changes in chemical composition and structure of steel used. Interruptions to make tests or adjustments slow production, increase costs, reduce the advantages of automatic operation. This makes the uniformity of the steel you use an even more vital factor. The more uniform the steel, the steadier the production and the greater the potential you can realize from your automatic equipment.

You can get the utmost in uniformity, and automatic operation—at no extra cost—by using Timken® fine alloy steel. Uniformity is constant from bar to bar, heat to heat, order to order.

We take many extra quality-control steps to assure this uniformity. For example, the Timken Company uses a magnetic stirrer for molten steel to assure equal distribution of alloys, uniform temperature and improved working of the slag. It's the first installation of its type in the United States.

To further assure uniformity, your order of Timken fine alloy steel is handled individually. We target our conditioning procedures to meet your end use requirements. Each bar is stamped to identify the heat it came from. This limits variations within an order as well as from order to order. And every heat is examined spectrometrically to insure uniform grain size.

To make your automatic heat-treating and hardening operations even *more* automatic—at no extra cost—always specify Timken fine alloy steel. You'll get money-saving performance and uniform results every time. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

TIMKEN *Fine Alloy* STEEL

TRADE-MARK REG. U.S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

AT YOUR FINGER TIP...

FISHER GIVES YOU "ON-THE-SPOT" SERVICE WITH...

3	22	53	203
FACTORIES	FIELD STOCKS	SALES OFFICES	SERVICE ENGINEERS

FISHER® SERVICE

You, personally, are "right next door" to an alert source of supply of Fisher control valves, gas regulators, liquid level controllers and pressure regulators.

Whether your problem is one of existing equipment—or an entirely new control application—the Fisher country-wide network of 3 factories, 22 strategically located field stocks and 53 representatives, with 203 Fisher Service Engineers—offers you convenient service on all your control requirements.

FISHER GOVERNOR COMPANY

Marshalltown, Iowa — *Woodstock, Ontario*

World Leader In Research for Better Pressure and Liquid Level Control

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ALBANY
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PRESSURE REGULATORS

GAS REGULATORS

LIQUID LEVEL CONTROLLERS

DIAPHRAGM CONTROL VALVES

PUMP GOVERNORS

LEVER AND FLOAT VALVES

Now! Enter against pressure safely... *at any time!*

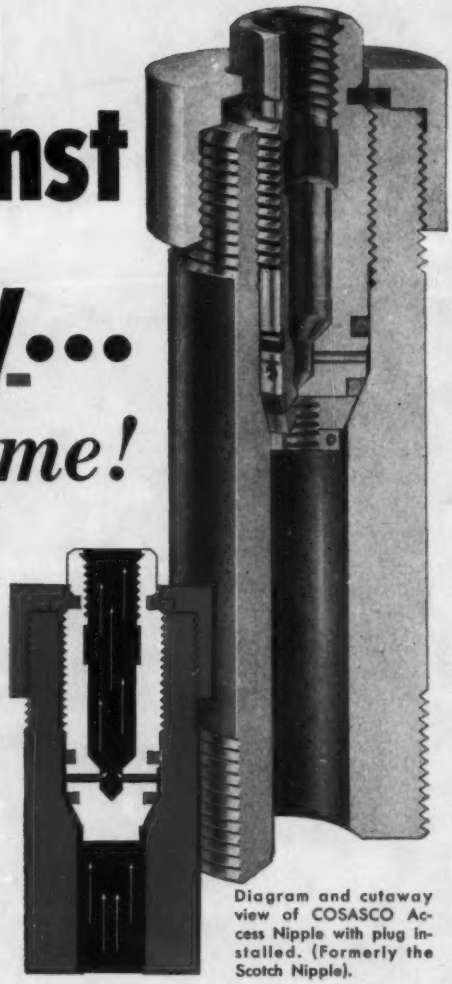


Diagram and cutaway view of COSASCO Access Nipple with plug installed. (Formerly the Scotch Nipple).

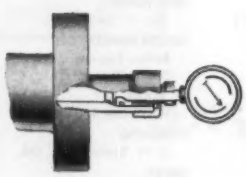
Wherever COSASCO Access Nipples are installed, you can go in against pressure with ease and perfect safety. At well heads, either the production string or annulus can be entered for instrument work. At refineries or along pipe lines, samplers, thermocouples, hydrogen probes, or coupons for corrosion studies can be inserted *without interfering with operations!* And expensive valves or other externals can be replaced or removed at will and without loss of pressure or product.

The COSASCO Access Nipple has a removable low carbon grade 303-304 stainless steel plug which, when turned down on the fine threads in the nipple outlet, effectively seals off the nipple at a tapered seat below. By-pass holes in the plug wall, between primary and secondary seals, provide communication through the plug to the exterior when the plug is backed out against a safety ring run down on the pipe threads on the nipple body.

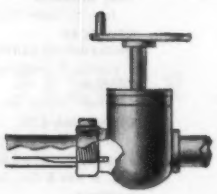
How entry is gained

With the COSASCO Retriever (Lubricator) and a full-opening valve mounted on the Access Nipple, COSASCO plugs, coupon holders or other units for inspection, testing, sampling, can be installed and removed at will regardless of pressure and without equipment shutdown. Details will be supplied promptly, on request.

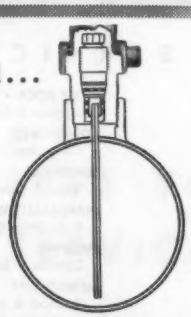
How **COSASCO** *Access* Nipples are used...



As a gauge valve, with plug installed. Gauge screws into end of plug.



As a valve re-installation nipple, with a thread and seat protector replacing the plug.



As a coupon holder for corrosion studies through taps in pipe lines and pressured vessels.

Protect equipment . . . Save product

What's your problem?

If it's an entry-against-pressure problem, COSASCO engineers invite you to submit details. Send blue prints and drawings to depict the problem, and the COSASCO solution will be supplied *without charge*. And you will be under no obligation whatever for this service.

COSASCO Access Nipples are applicable to any pressure or storage system, hydraulic or gaseous.

COSASCO

Division of Perfect Circle Corporation

3463 Ocean View Boulevard, Glendale 8, California

Address Mail to P.O. Box 277, LaCanada, California • Export Office: 617 S. Olive Street, Los Angeles 14, California

World's Largest Acetylene Plant

from Natural Gas
(BASF Acetylene Process)

ENGINEERED AND BUILT BY

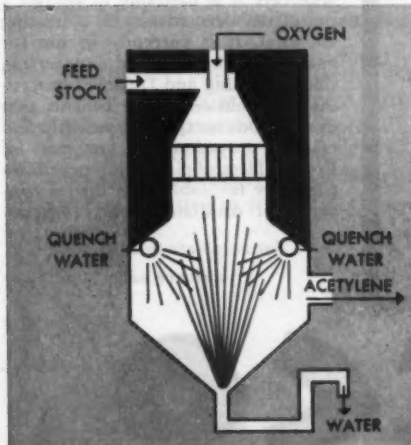
CHEMICO

The BASF* **Acetylene Plant** of American Cyanamid Company at Avondale, Louisiana, engineered and built by CHEMICO, is now being increased in capacity, making it the WORLD'S LARGEST ACETYLENE PLANT OF ITS TYPE.

By 1957, all the plants engineered and built by CHEMICO for the production of acetylene from natural gas will have a total capacity of 150,000,000 pounds per year.

Important features of the BASF process are listed below, and reprints of article describing this process are available upon request.

* Badische Anilin & Soda Fabrik, AG, West Germany, holder of the basic acetylene process for which CHEMICO has exclusive rights in all North American Countries.



Features of the BASF Acetylene Process

Produces commercially pure acetylene, meeting specifications for the manufacture of acetylene derivative products such as Acrylonitrile, Vinyl Chloride, Methylstyrene, etc.

Permits the use of a variety of feed stocks such as Methane, Ethane, Propane and other petroleum gases.

Produces off-gas suitable for Ammonia and Methanol synthesis.

Permits integrated production of Acetylene and Ammonia to meet changing market demand.

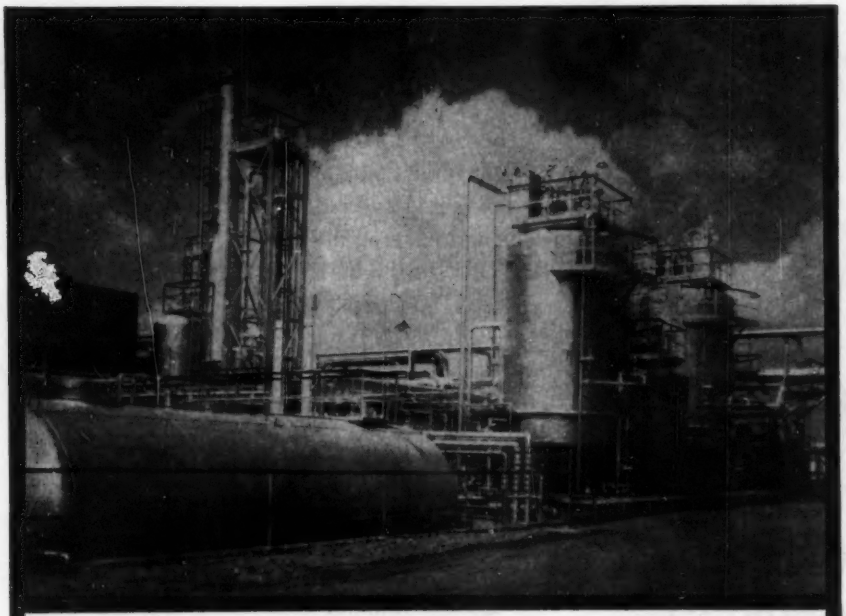
CHEMICAL CONSTRUCTION CORPORATION
A SUBSIDIARY OF ELECTRIC BOND AND SHARE COMPANY
525 WEST 43RD STREET, NEW YORK 36, NEW YORK

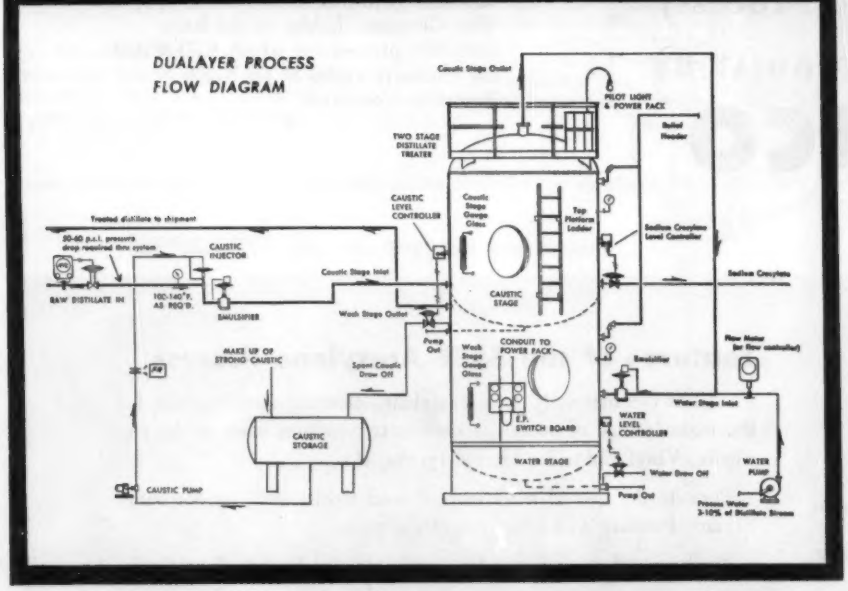
CC319

For more data on advertised products, use Readers' Service Cards, last page.

PETRECO ELECTROFINING

PROVIDES IDEAL TREATING CONDITIONS FOR ANY TYPE OF DISTILLATE TREATING





The photo and flow diagram at the left show Petreco Electrofining equipment utilized in the Distillate Fuel Oil Dualayer Process at the Magnolia Petroleum Company refinery at Beaumont, Texas.

In the Dualayer process, as designed by Magnolia engineers, distillate fuel oils are stabilized as to color and sediment formation. This is accomplished in Petreco equipment by contacting oils with a solution of concentrated sodium hydroxide or potassium-hydroxide. The salts of the organic acids, such as aromatic mercaptans, cresols and phenols, are insoluble in both the distillate and caustic. These liquid salts are withdrawn automatically from a layer intermediate between the distillate and caustic. The caustic is recycled for further distillate treatment. In the Electrofining vessels, treating losses are held to a fraction of 1%, consisting of only reaction products which are removed from the oil. After chemical treatment, the overhead distillate stream is water washed for removal of residual alkalinity. The wash water is removed from the distillate in a final stage of Petreco precipitation.

The two stage and three stage Petreco Electrofining equipment facilitates the operation of the Dualayer Process by providing an efficient means of precision-controlled, continuous mixing and separation. The Plant illustrated (left) has a treating capacity of 30,000 barrels per day of cat cracked distillate fuel.

Petreco Electrofining is applicable wherever it is desirable to contact a petroleum derivative with a treating chemical. It is currently in use for caustic scrubbing, acid contacting, doctor treating and Dualayer processing. In addition to the benefits that derive from inexpensive, reliable and efficient operation, the first costs of Petreco Electrofining equipment compare very favorably with that of conventional distillate treating systems.

For complete information, write or call

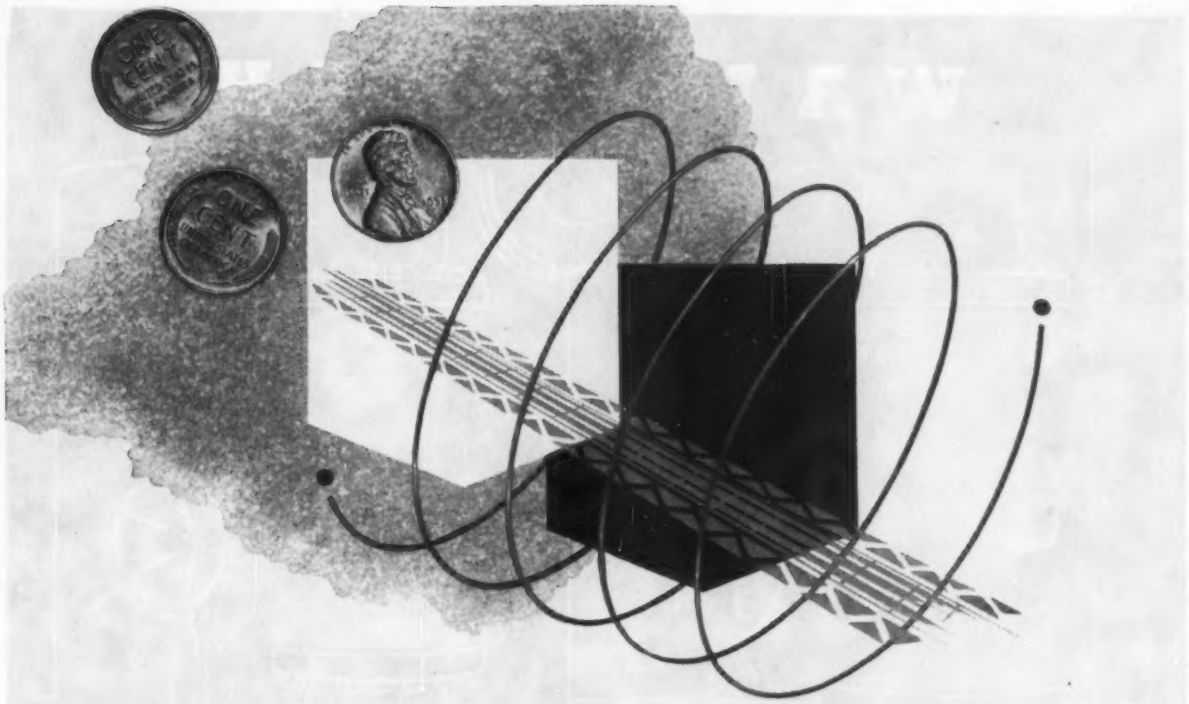
PETRECO®

A DIVISION OF PETROLITE CORPORATION

3202 South Wayside Drive, Houston 1, Texas • 1390 East Burnett Street, Long Beach 6, California

SPECIALIZED ELECTRIC PETROLEUM PROCESSING: DESALTING • DEHYDRATING • DESAPONIFICATION DISTILLATE TREATING • SEDIMENT SEPARATION

DT-11



QO® FURFURAL OFFERS FLEXIBILITY, HIGH RECOVERY, AND LOW SOLVENT COST IN EXTRACTION OF BUTADIENE

QO Furfural has the unique ability to alter relative volatilities of butadiene and other C_4 hydrocarbons. This permits easy separation of compounds differing in degree of unsaturation.

Special advantages of using furfural include:

FLEXIBILITY: Furfural is effective in separating butylenes as well as butadiene, thus a furfural unit can be used to prepare both alkylate stock and butadiene. The process employs petroleum-type equipment, which can be adjusted to a variety of operating conditions.

HIGH RECOVERY: Good selectivity of the solvent assures high butadiene recovery; excellent stability of the furfural assures almost quantitative recovery of the solvent itself.

LOW SOLVENT COST: QO Furfural is produced in large quantities from agricultural residues—not from the valuable food or fiber portions of the plant. This helps keep prices low and stable.

QO Furfural is a proved, safe, low cost way of producing butadiene of highest purity. Write for information on extractive distillation and Bulletin 203-A entitled Physical Data on QO Furfural.

The Quaker Oats Company
CHEMICALS DEPARTMENT

The Quaker Oats Company — CHEMICALS — QO — FURAN CHEMICALS — DEPARTMENT

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Chicago 54, Illinois

Room 540U 120 Wall Street,
New York 5, N. Y.

Room 440U 48 S.E. Hawthorne Blvd.
Portland 14, Oregon

In the United Kingdom:
Imperial Chemical Industries, Ltd., Billingham, England

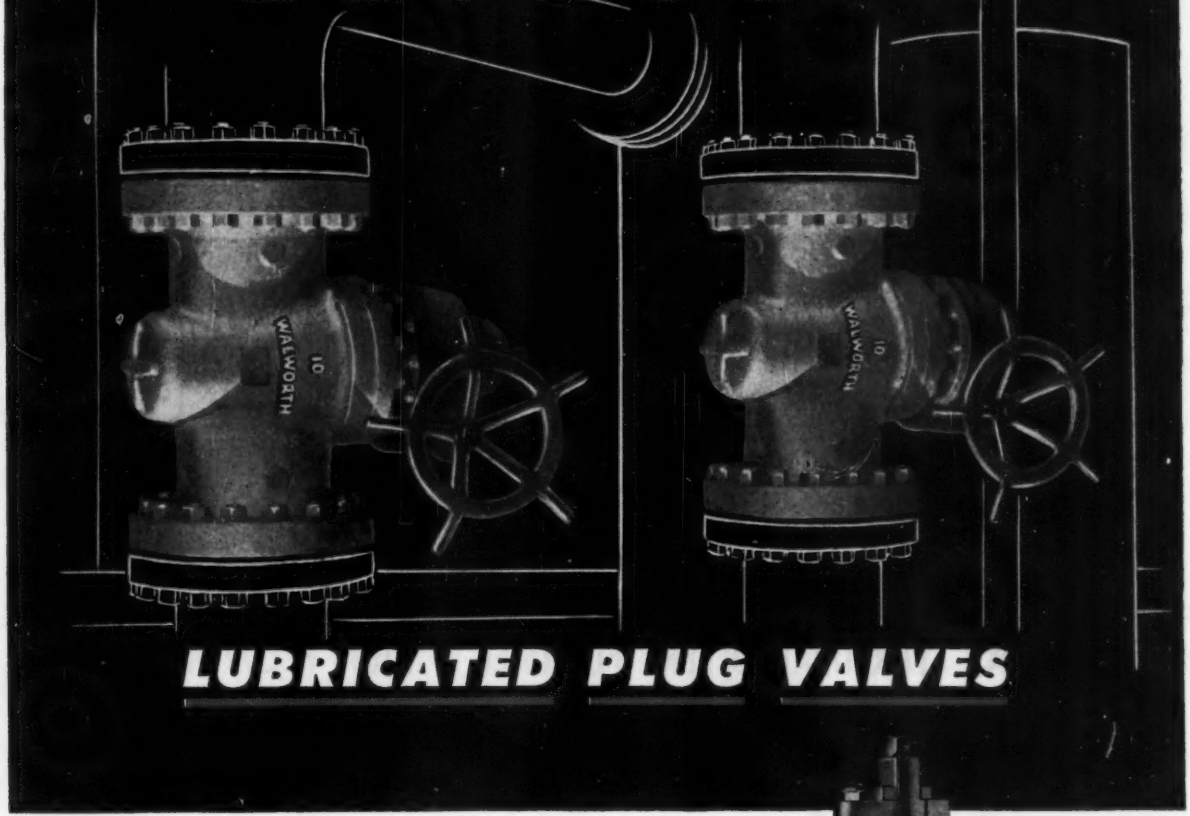
In Europe:
Quaker Oats-Graanproducten N. V., Rotterdam, The Netherlands;
Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France;
A/S "Ota", Copenhagen, S. Denmark

In Australia:
Swift & Company, Pty., Ltd., Sydney

In Japan:
F. Kanematsu & Company, Ltd., Tokyo

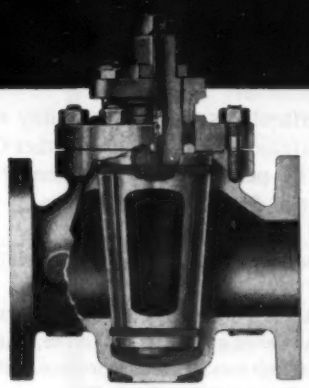
For more data on advertised products, use Readers' Service Cards, last page.

WALWORTH



LUBRICATED PLUG VALVES

Better because ... **They are pressure sealed with an insoluble lubricant readily renewed while the valve is in service. Lubricant completely surrounds the plug ports assuring a tight seal against leaks. It also insures ease of operation by reducing friction between the body and the plug while at the same time protecting the finished surfaces against corrosion and wear.**



Lubricant system of a Walworth No. 1700F Regular Gland, Wrench Operated, Steel-iron, *Lubricated Plug* Valve. Other Walworth *Lubricated Plug* Valves include Single Gland, and Ball Bearing types. Sizes to 30-inches — pressures to 5,000 psi, and for vacuum service.

Walworth Lubricated Plug Valves are the most satisfactory valves available for the handling of gritty suspensions, and many other destructive, erosive, and corrosive industrial and chemical solutions.

They are ideal for general refinery and pipeline service.

For full information see your Walworth Distributor, or write for your copy of Bulletin 111. Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.

WALWORTH

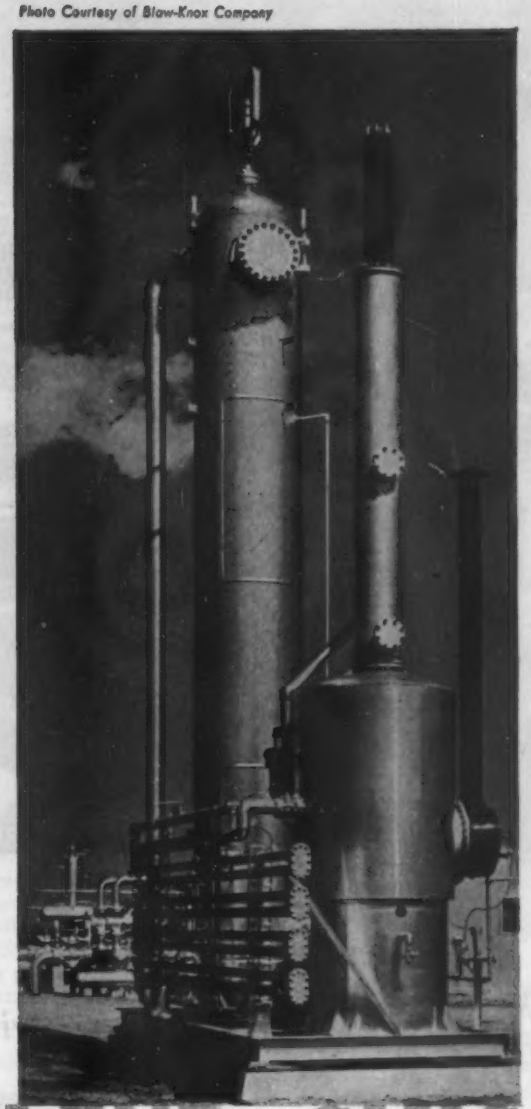
Manufacturers since 1842

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Photo Courtesy of Blaw-Knox Company



gas dehydration at lower capital cost, lower operating cost
... with

TRIETHYLENE GLYCOL

- High dew point depression—50° to 85°F.
- Easily regenerated to 98-99% solution in an atmospheric stripper
- Stable in the presence of sulfur, oxygen, and CO_2 at normal operating temperatures
- Carry-over losses are small • Does not solidify in concentrated solution • Noncorrosive
- High theoretical decomposition temperature—404°F. • Low vaporization losses

Initial cost of a TEG dehydration plant is usually less than half that for certain types of dessicant plant. And operating costs are only ⅛ to ½—with lower dessicant make-up cost. Our technical service man will be glad to consult with you if you're thinking about a new plant—or about the feasibility of converting an existing one.

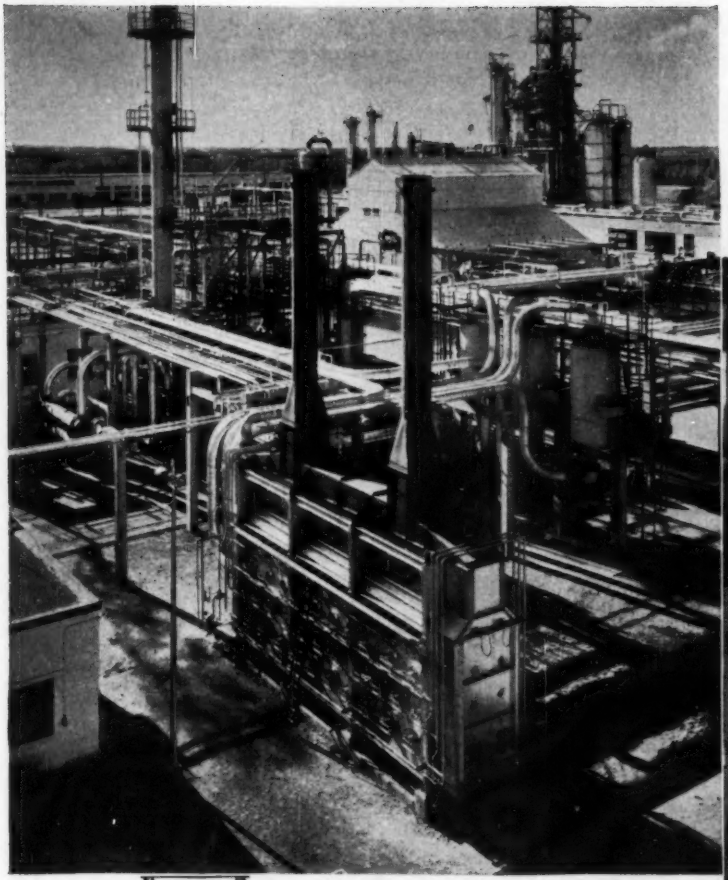
If you currently use TEG, write for a typical analysis, quotation and free sample of our material. It's extremely low in iron, chlorides, acidity and water.

G 1-20-1

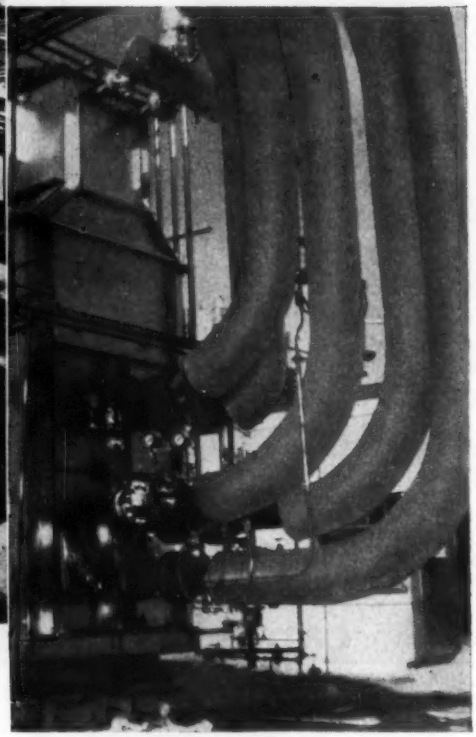
Allied Chemical — NITROGEN DIVISION

40 Rector Street, New York 6, N. Y.

Ethanolamines • Ethylene Oxide • Ethylene Glycols • Urea • Formaldehyde • U. F. Concentrate – 85 • Anhydrous Ammonia • Ammonia Liquor • Ammonium Sulfate • Sodium Nitrate • Methanol • Nitrogen Solutions • Nitrogen Tetroxide • Fertilizers & Feed Supplements



Split-Second Response... ±1°F Control In Catalytic Reforming at Imperial Oil Ltd.



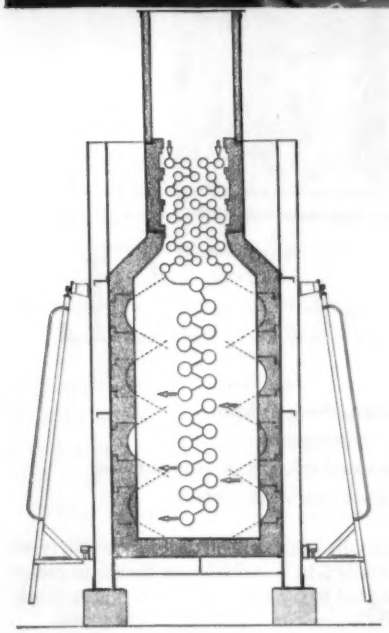


Diagram illustrates the flow of material through the multiple coils during preheat, first and second reheat cycles.

...with Selas Gradiation® Heating

Instantaneous response to changes in operating conditions with a temperature variation of only ±1°F... is the most important contribution of this Selas furnace installation at Imperial Oil, Ltd., Edmonton. Add Zone Control, which permits independent heating of multiple coils in a single radiant chamber; longer tube life because of non-oxidizing furnace atmospheres and you will understand the trend to Selas Gradiation Heating.

Send for Bulletin 142 "Gradiation Heating for Petroleum and Chemical Processing."

SELAS
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

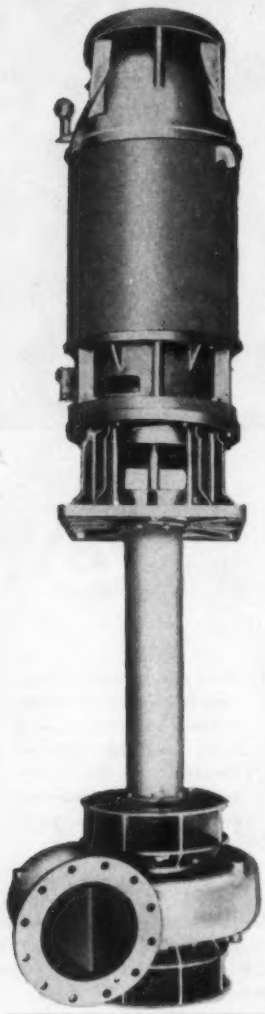
Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION

Bingham

TYPE "VS" DOUBLE SUCTION DOUBLE VOLUTE VERTICAL PUMP

REDUCES COSTS WITH SHALLOW PIT LOWER MAINTENANCE



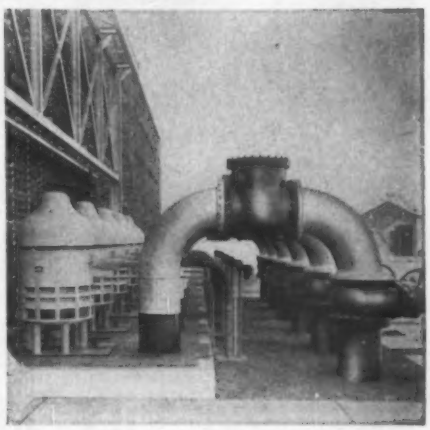
SPECIALLY DESIGNED FOR WET-PIT SERVICES. COOLING TOWER, SPRAY POND, DISPOSAL SUMP, WATER SUPPLY, DRAINAGE — AND OTHER HIGH-CAPACITY, MEDIUM-HEAD WET-PIT SERVICES.

The BINGHAM "VS" Pump, which is an advanced design of a "Double Volute"—"Double Suction" single stage pump, saves money in three ways: (1) Lower installed cost because it does not require a deep pit and can use standard motors. (2) Lower operating cost, because it operates at higher efficiencies, uses less power. (3) Lower maintenance cost, because there is no stuffingbox, all bearing loads are light, and the installation is easy to inspect and service.

The "Double Volute" construction of the "VS" Pump maintains radial balance of its rotating element throughout the entire operating range of the pump. Wear due to "Side Push" is eliminated.

The "Double Suction" feature of this pump eliminates axial hydraulic thrust, thereby permitting the use of standard vertical motors.

These and many other important reasons make the BINGHAM "VS" Pump the most logical choice today for wet pit service. For full details call your nearest Bingham Office or write for Bulletin No. 110.

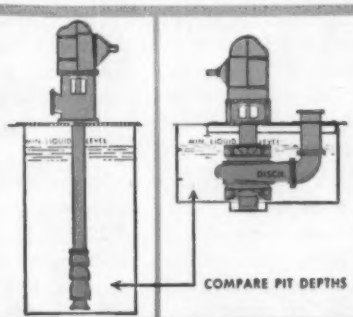


A Battery of Bingham "VS" Pumps Operating at a major Gulf Coast gas processing plant.

COMPARE THESE PITS FOR COST

OLD

Conventional Deep-Well Turbine Pump Installation . . . requires the pit be deep enough to maintain sufficient pumpage above the pumping element in order to provide the required NPSH.



NEW

Bingham "VS" Pump Installation . . . requires only a shallow pit and only sufficient pumpage to cover the pumping elements. Pit construction is thereby greatly reduced.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

General Offices: **2800 N.W. Front Avenue, Portland 10, Oregon**

Factories: **Portland, Ore. • Vancouver, B. C., Canada**

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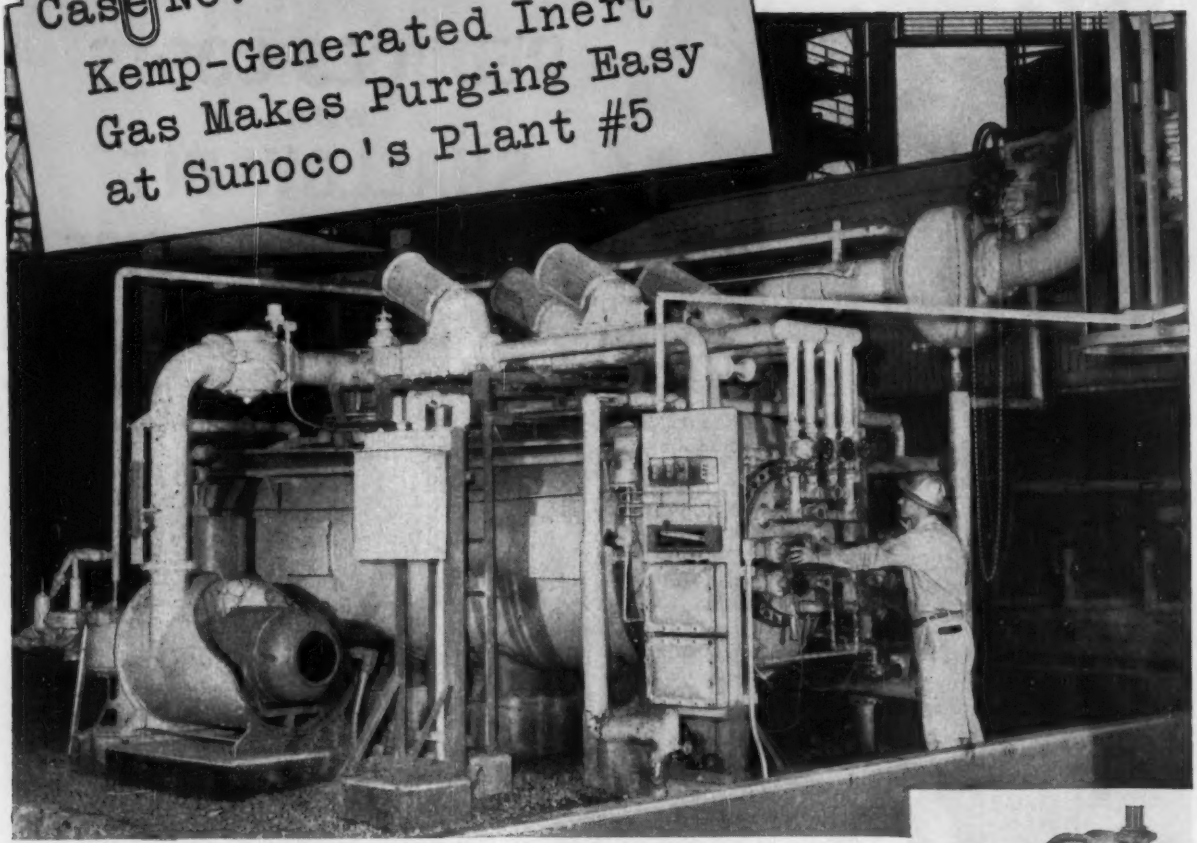
For more data on advertised products, use Readers' Service Cards, last page.

Case No. 57
Kemp-Generated Inert Gas Makes Purging Easy at Sunoco's Plant #5



How Sun Oil's "Magic Mill" at Toledo operates with 'round the clock safety

There's no *one* word that strikes terror in the hearts of oilmen everywhere more quickly than F-I-R-E! To combat this threat at the Sun Oil Co.'s giant refinery at Toledo, Ohio, constant vigilance, checks and inspections are the answer. And the liberal use of inert gas for purging pipelines, tanks and crackers is essential to this safety maintenance.

Kemp selected to do the job

When plans called for *doubling* plant production in 1950, a new Kemp Generator (see above) was installed to insure adequate inert gas production. Fast-starting, easy-to-operate, this Kemp unit more than filled the bill. Today tanks and lines are periodically purged for inspection and cleaning *as often as needed*. And thanks to its 60,000 cu. ft. per hr. Kemp Inert Gas Generator, Sunoco enjoys *exact analysis* inert production that meets all its purging requirements.

Let Kemp help you, too

If you have a purging or blanketing problem, why not let Kemp Engineers give you the same helpful advice used so profitably at Sun Oil's Toledo refinery. It costs you nothing to investigate. And it may save you money. Find out how Kemp's wide range of dependable, low-cost Generators (complete with the latest fire checks and safety devices) offer you the best way to solve your problems.

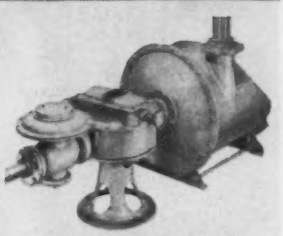
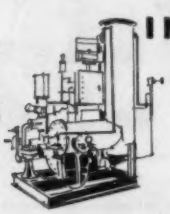


Photo above shows close-up view of Kemp Industrial Carburetor, the heart of every Kemp installation. Assures complete combustion... without waste, without tinkering. Reduces installation costs, simplifies maintenance.

***For more complete facts and technical information, write for Bulletin I-10 to:* C. M. KEMP MFG. CO., 405 E. Oliver Street, Baltimore 2, Maryland.**

KEMP OF BALTIMORE

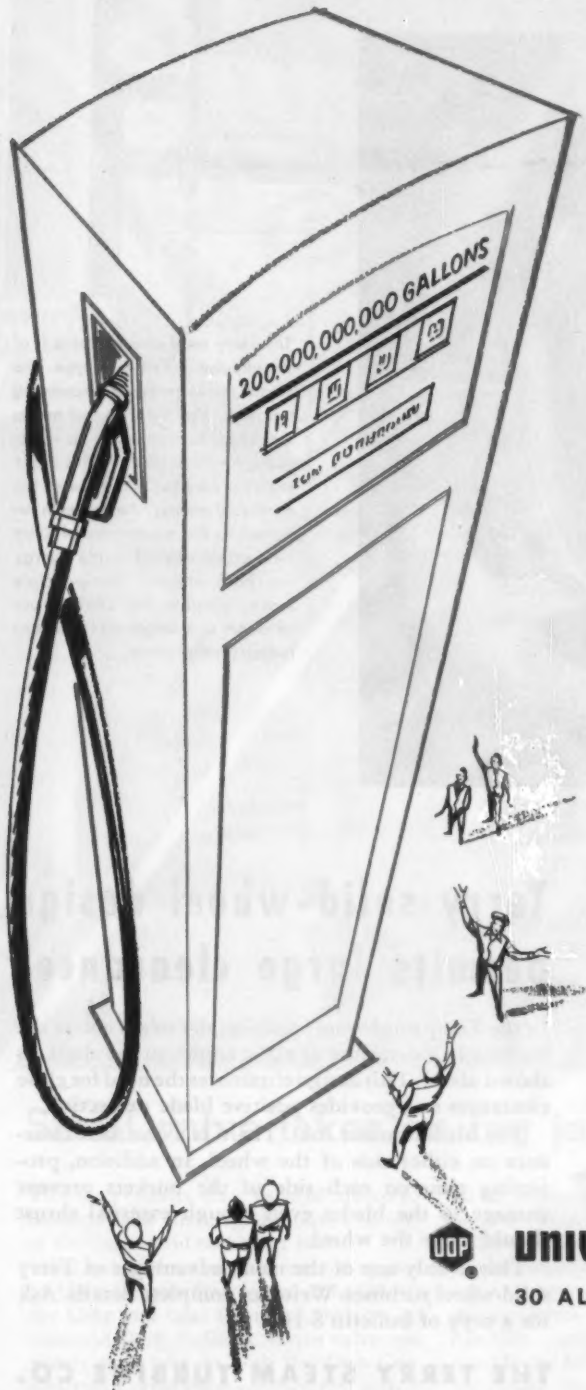


INERT GAS GENERATORS

CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • ADSORPTIVE DRYERS • SINGEING EQUIPMENT

More than 200,000,000,000 GALLONS

OF GASOLINE KEPT GUM-FREE WITH UOP #5 INHIBITOR



Any way you figure it, that's a lot of gasoline . . . convincing proof that the petroleum industry has approved and demanded UOP #5 Inhibitor.

Obviously, there are good, sound reasons for this preference. UOP #5 has demonstrated unexcelled inhibitor potency and versatility. It is the product you can depend on for the really tough stability jobs.

UOP #5 is economical. For any given stability requirement you can't beat #5 on a cents (or fraction thereof) per barrel basis. Remember, five molecules of UOP #5 will protect 1,000,000 molecules of gasoline.

UOP Inhibitor #5 was introduced by Universal during World War II and the techniques of applying it have been effectively developed over the years. This experience is offered to refiners, and our on-the-spot representative will be glad to assist in its application to your products. Just write us.

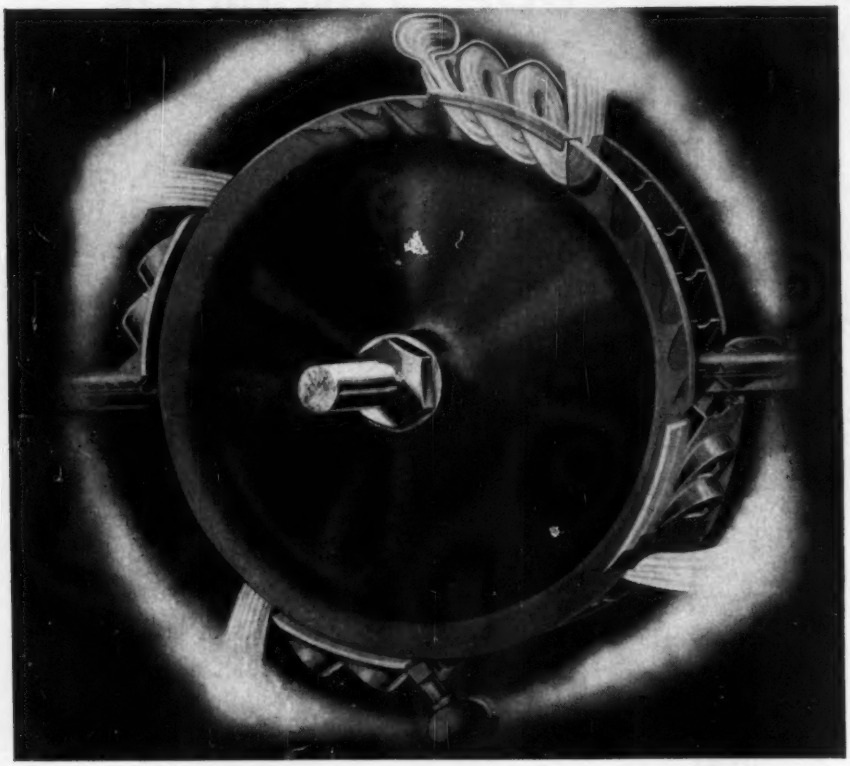
PRODUCTS DEPARTMENT

UNIVERSAL OIL PRODUCTS COMPANY

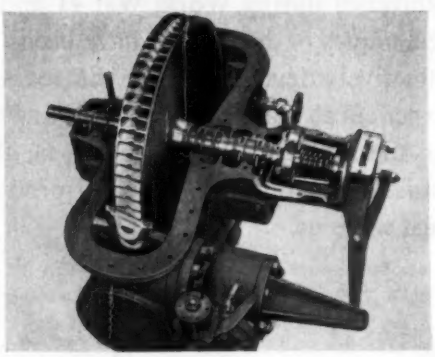
30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U. S. A.

For more data on advertised products, use Readers' Service Cards, last page.

TURBINE BLADES CAN'T FOUL!



The Terry solid-wheel turbine is of the impulse, helical flow type. The steam issues from an expanding nozzle at high velocity and enters the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is returned to the wheel several times until practically all of the energy has been utilized. This principle makes possible the efficient use of steam in a single-piece, almost indestructible wheel.



Terry solid-wheel design permits large clearances

In the Terry solid-wheel turbine, the steam enters the buckets in a direction at right angles to the shaft, as shown above. This design eliminates the need for close clearances and provides positive blade protection.

The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though external thrust should move the wheel.

This is only one of the many advantages of Terry solid-wheel turbines. Write for complete details. Ask for a copy of bulletin S-116.

TERRY

TT-1206

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

For more data on advertised products, use Readers' Service Cards, last page.

Small valve takes on big job at U.S. Steel

That's a 4" Aloyco Gate Valve of Aloyco 20 stainless steel guarding the outlet of one of the largest acid tanks ever built.

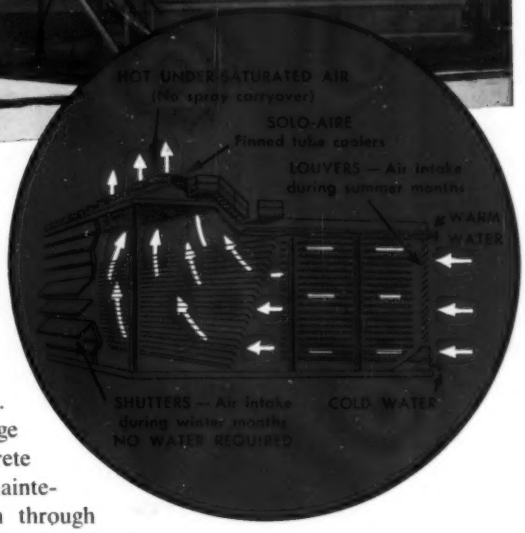
It's one of the new units erected as part of United States Steel's modernization of the Coke and Coal Chemical Division facilities at Gary, Indiana. Aloyco valves are widely used here in both the Otto Construction Corporation's ammonium sulfate saturators and in the solvent recovery units which were engineered by United Engineers & Constructors, Inc.

They're also widely used by other leading manufacturers in the chemical processing and petroleum industries. Perhaps Aloyco valves could save you money in handling corrosives. Want more information? Write Alloy Steel Products Company, Inc., 1301 West Elizabeth Ave., Linden, New Jersey.

6.27

HUDSON Combin-aire

LOW TEMPERATURE COOLING USING COMBINATION OF MINIMUM WATER AND MAXIMUM AIR



Where quantity or quality of water is low, and ambient air temperatures too high to permit direct cooling with air, process plant designers find the modern solution in Combin-aire. In addition to large savings through minimizing water consumption and eliminating water treatment, Combin-aires incorporate many other advantages.

The Combin-aire pictured above, installed in a large gas processing plant in northern Mexico, is of concrete construction, eliminating fire hazard and minimizing maintenance. As shown in the cut-away drawing, air is drawn through cooled water by fans located on top of the structure. The air, precooled and washed free of solids by the water, flows across the finned tube coolers, and leaves the top of the Combin-aire at elevated temperature under-saturated with water vapor. Mist carryover, condensation from effluent air, and air recirculation are thus eliminated. Combin-aires are installed adjacent to process equipment, minimizing piping and concentrating operating area.

In winter, air flows directly to the Solo-aire finned coolers, water circulation being unnecessary. Where water is required for shell and tube units or atmospheric sections, such water may also be cooled in the Combin-aire unit, eliminating the conventional cooling tower.

In addition to Combin-aire units, Hudson manufactures water cooling towers, air-cooled and water-cooled coolers and condensers, and is experienced in plant layout, piping, and water treatment. We shall be glad to assist prospective plant owners in making overall comparisons of first costs and operating costs for complete cooling systems using various combinations of equipment.

HUDSON
ENGINEERING CORPORATION
FAIRVIEW STATION • HOUSTON, TEXAS

405 Lexington Ave., New York 17, N. Y. • 2500 W. Sixth St., Los Angeles 57, Calif. • Corrientes 1115, Buenos Aires, Argentina

For more data on advertised products, use Readers' Service Cards, last page.

Compressor house at Standard Oil Company's new Ultraformer, Cleveland, Ohio.

This Type BY Lectrodryer* dries 80 cfm. of compressed air to a dewpoint of -20° F.

Indoor security for outdoor equipment

Freezing weather and high humidity won't bother this open-air equipment and the refinery it serves. It's proof against the elements. Consider the instrument air, for example—

This compressed air passes through the Lectrodryer—is dried DRY. No freezeups. No moisture to form mud or rust to clog tiny instrument ports.

Bulletin 223-B will tell you about this DRYing help. For a copy, write Pittsburgh Lectrodryer Company, 307 32nd Street, Pittsburgh 30, Pennsylvania. (a McGraw Electric Company division)

Lectrodryer

*REGISTERED TRADEMARK U. S. PAT. OFF.

For more data on advertised products, use Readers' Service Cards, last page.

STREAM BLEND LUBES...

pay-out proven!

NO SLOP . . . NO NEED TO DOWN-GRADE . . . AUTOMATIC BLOWBACK eliminates slop when base stocks and additives are realigned.

ACCURACY . . . CLOSED CONTROL LOOP PRINCIPLE AND PNEUMATIC SYSTEM eliminating back-loading of meters, give instantaneous control response. Memory feature inherent in control system assures correct end product. Recirculation system permits formulation check prior to blending.

FAIL-SAFE OPERATION . . . ELECTRICAL INTERLOCK SYSTEM provides "fail-safe" operation and isolates blend manifold on departure of any component from set formulation.

VERSATILITY . . . TOTAL OUTPUT RATE quickly adjusted to suit production requirements without affecting blend ratio.

EASE OF EXPANSION . . . UNITIZED CONSTRUCTION permits future expansion at minimum cost. Built-in totalizers provide continuous performance and inventory check.

ONE USER TESTIFIES after only 6 months of operation, "The savings effected to date . . . represent better than one-third the cost of the plant."

ONE USER ALSO TESTIFIES . . .

"Our Proportioneers blending machine has proven to be extremely accurate (will hold a 78 SUS at 210°F viscosity oil within plus or minus 0.3 SUS). It is also very dependable, easily controlled, reasonably foolproof, and impressive in appearance. We are very well satisfied with it."

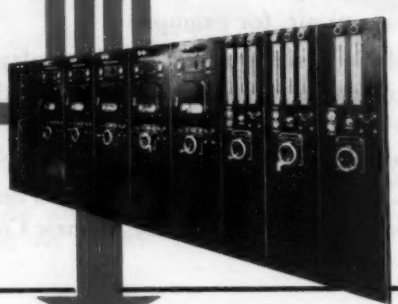
"The unique 'test blend' and component totalizing features incorporated in the Proportioneers blending machines are extremely useful and excellent safeguards. Such features take on even greater importance where operating personnel are limited in experience and know-how."

"'Slop losses' due to carryover can be reduced practically to zero."

"Such machines (Proportioneers LUBE OIL BLENDERS) are justified by reduced labor, more continuous production, reduced floor space, better control of production, ease of expansion, and greater sales appeal."

FURTHER JUSTIFICATION . . .

Let one of our sales engineers show you how a Proportioneers Blender can justify pay-out on 50,000 barrels or more annually. Request Bulletin SM-2055 for complete data.



Write to
PROPORTIONEERS, INC.
412 Harris Avenue,
Providence, R. I.

PROPORTIONEERS, INC.
DIVISION OF
B-I-F INDUSTRIES
PROVIDENCE, RHODE ISLAND
METERS FEEDERS CONTROLS

US RUBBER

MATCHLESS STEAM HOSE

"U. S. Matchless #5 does 5 different jobs,"

says refinery division superintendent

"It always passes our strictest lab tests."

A mechanical division superintendent of a leading Midwestern refinery says:

"U.S. Matchless Steam Hose always passes our central maintenance department tests, and we've always had good experience with it. The neoprene cover is oil-resistant. The hose is highly flexible and light in weight. Asbestos ply, under the cover, conserves heat. Wire braid preserves static ground."

This great "U.S." hose is serving many industries in many ways. It is obtainable at selected "U.S." distributors, at any of the 28 "U.S." District Sales Offices, or write us at Rockefeller Center, New York 20, N. Y.

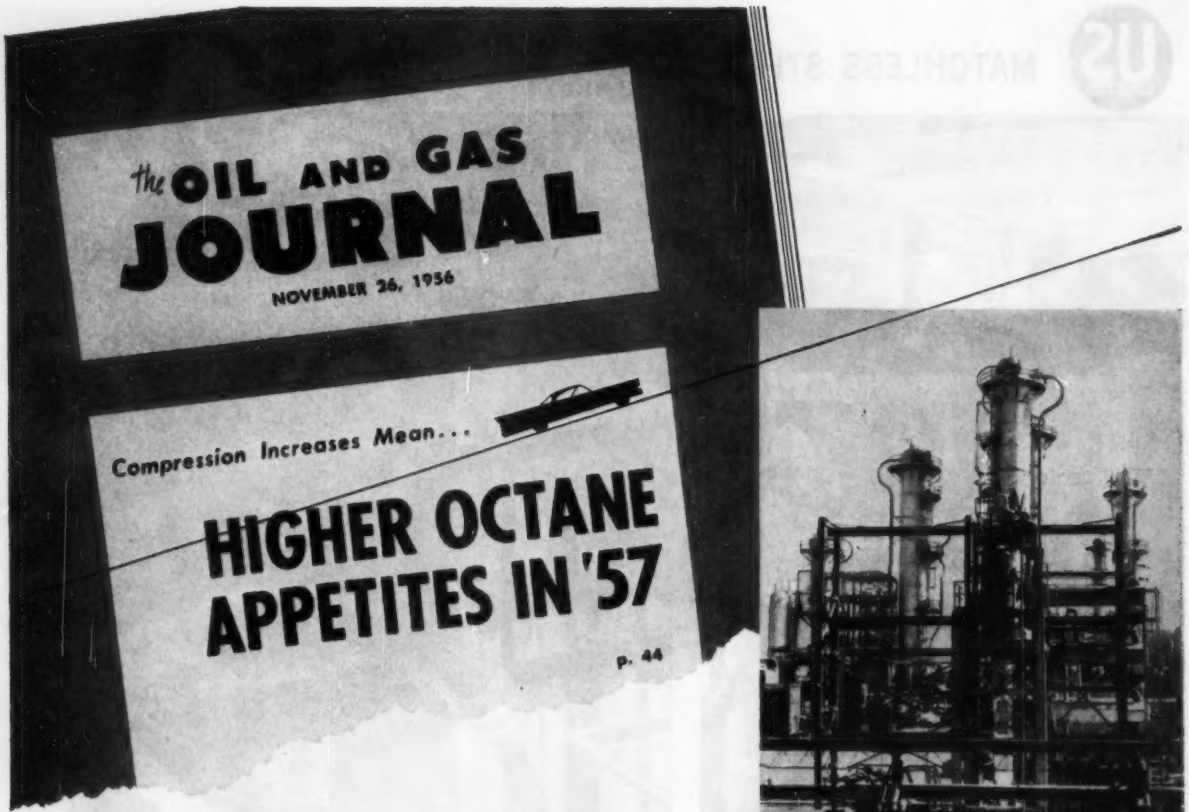
Uses in refinery for U.S. Matchless® #5 Hose:

- As a firefighting hose, for safety-checking atop the 235-ft. cracking unit (see picture above).
- In propane tank, to thaw bottom of gauge glass in cold weather (see inset picture above).
- In pump room of cracking unit, as a steaming line to get gas traces out of the unit.
- On propane transfer line, to prevent orifice from freezing in cold weather.
- Enables construction crews to run temporary steam lines more cheaply and quickly than using pipe.

US RUBBER

Mechanical Goods Division

United States Rubber



Booming high octane market spurs alkylation...

Monel resists HF corrosion... permits safe, non-stop operation for a year or more

Boosting pool octane values calls for quantity as well as quality in the premium fraction.

So, in HF alkylation, the heat's on for (1) high-stream velocity and (2) non-stop operations.

But with increases in stream velocity, the HF corrosion rate may go up. Without special protection, more inspection shutdowns are called for.

To get around the impasse producers rely on Monel

Major operators have increased their onstream time to a year or better by using Monel* nickel-copper alloy freely in critical equipment. One company reports a two-year inspection schedule.

These companies depend on Monel alloy to resist both aqueous and anhydrous HF attack at elevated temperatures and pressures.

In acid regenerators, steam reboilers, feed pre-heaters, condensers, fractionating towers... Monel alloy or Monel-clad construction provides years of trouble-free life.

In valve, pump, and instrument parts with close tolerances, it eliminates undesirable build-up of corrosion products. As relief valve rupture discs and gaskets, it helps assure safe operation.

Chances are, Monel alloy could help you increase throughput and operate safely over longer periods.

Look into the matter today. Write Inco's Corrosion Engineering Section.

*Registered trademark

When to consider Monel for HF alkylation equipment. Monel nickel-copper alloy provides useful resistance to HF in all concentrations and (in unaerated solutions) up to 250°F. It is used with the anhydrous acid at temperatures up to 1100°F. Monel is comparatively unaffected by high stream velocities. Its strength and wear resistance are high.

INCO TRADE MARK **Nickel Alloys**

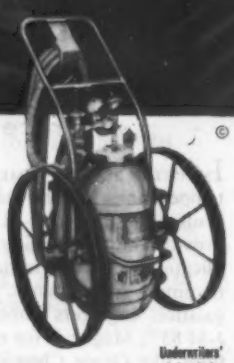
The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

Monel ... for minimum maintenance

This small fire won't mean tragedy!

America's multi-million dollar Petroleum and Gas Industries are safeguarded from fire by thousands of Pyrene-C-O-Two *safety-engineered* extinguishers and systems!

For all types of flammable liquid fires there are Pyrene-C-O-Two units tailored to your needs. Call your local Pyrene-C-O-Two distributor today for his authoritative advice on fire protection. He carries a complete line of quality extinguishers, systems, brass goods, hose and accessories... and is ready to serve you. Or write to:



Underwriters' Laboratories and Factory Mutual Approved

Pyrene C-O-TWO

PYRENE-C-O-TWO DIVISION

THE FYR-FYTER COMPANY

Dept. PR Newark 1, New Jersey

BRANCHES IN ATLANTA • CHICAGO • DALLAS • DETROIT • SAN FRANCISCO

J-M 85% Magnesia is lightweight . . . easy for workmen to install half-sections on this 10" steam line. Insulation work at the Grace Chemical plant was performed by Young Sales Corporation of St. Louis. Engineering and construction was directed by Foster Wheeler Corporation of New York.

Your Btu's and dollars go further when you specify **Johns-Manville 85% Magnesia**

. . . the choice of insulation engineers at Grace Chemical's new Memphis plant

INDUSTRY'S LONG-TIME standard for temperatures to 600F is still your best insulation buy. For J-M 85% Magnesia provides high insulating value, easy application, long life, initial low cost and minimum maintenance. That's why insulation engineers consistently specify J-M 85% Magnesia for modern installations like Grace Chemical's new anhydrous ammonia-urea plant. That's why it will pay you to specify J-M 85% Magnesia for your new plant or modernization program.

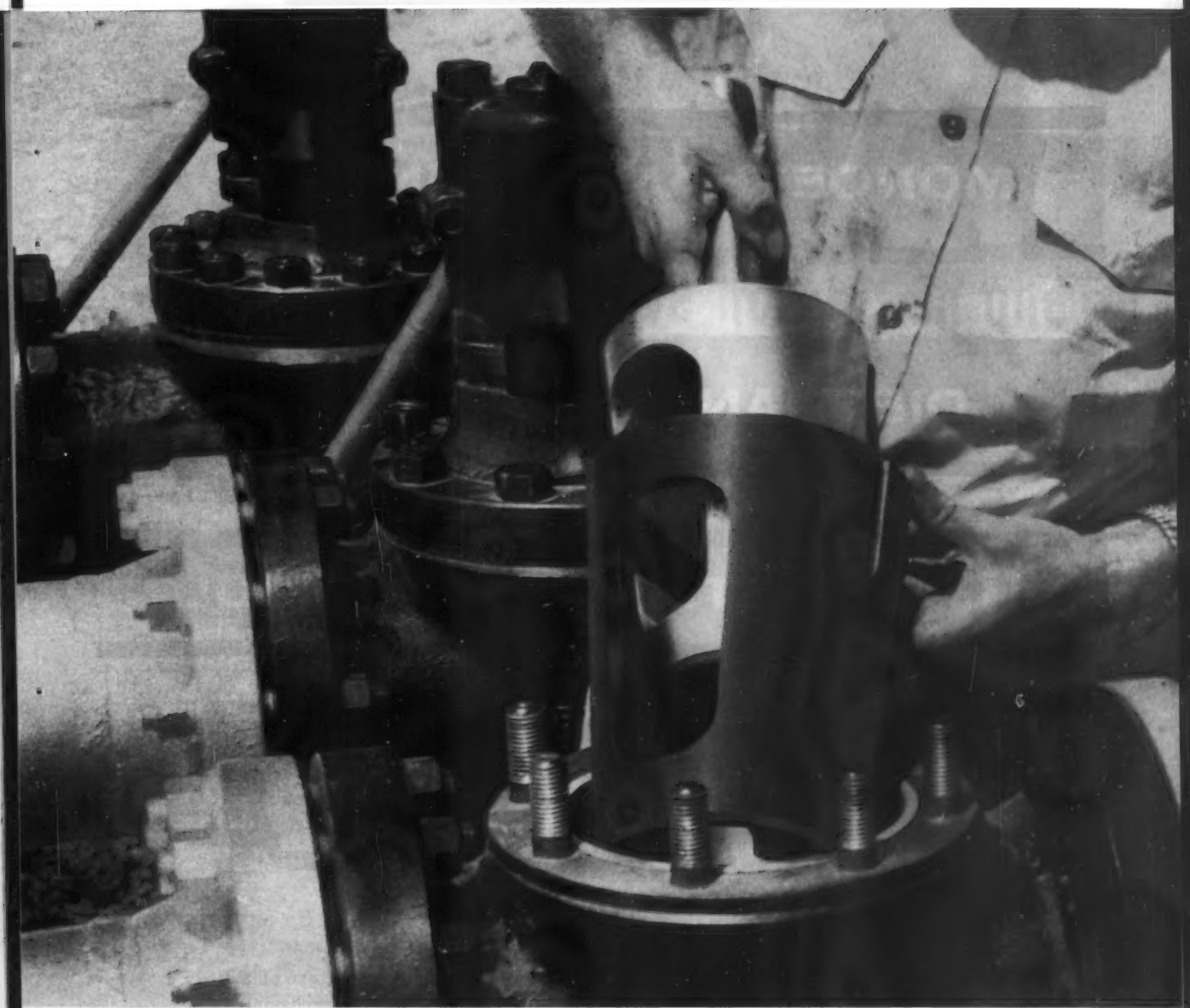
To assure you maximum value from your insulation dollar, Johns-Manville gives you complete drawing-board-to-job-site service. You get expert recommendations by the world's most experienced insulation engineers . . . plus expert installation by authorized J-M Insulation Contractors. Write today for further information on J-M 85% Magnesia and Johns-Manville's unmatched facilities to solve your insulation problems. Address Johns-Manville Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.

J-M 85% Magnesia also comes in block form. Here you see it being applied to a vertical drum at a New Jersey petroleum refinery.

Johns-Manville *first-in* INSULATION

MATERIALS · ENGINEERING · APPLICATION

For more data on advertised products, use Readers' Service Cards, last page.



LPG --NO LONGER A PROBLEM

CAMERON LIFT-PLUG VALVE WITH HYCAR IS THE ANSWER

More and more operators every month are spending time on something beside valve maintenance and repair. The Cameron Non-Lubricated Lift-Plug Valve fitted with a Hycar nitrile rubber-coated seat is doing the job on three counts:

1. HOLDS LIGHT HYDROCARBONS – A SHUT-OFF SHOULD BE A SHUT-OFF (Seal-Tight, Jug-Tight, Bubble-Tight).

2. NON-LUBRICATED–Let's face it, LPG Valves are either valves or a specialized maintenance program. The Cameron Hycar Lift-Plug needs no grease guns – no regular maintenance plan – no lubrication to go (you know where) down the line.

3. LONG LIFE – The Hycar coating on the interchangeable seats of these valves provides resiliency, yet shows no swelling or dimensional changes despite continued exposure to a variety of hydrocarbons, water, oil and many solvents and chemicals.

Here is our present range:
ASA (rectangular opening)
Sizes: 2", 3", 4", 6" and 8".
Rating: 150 lbs., 300 lbs., 600 lbs. and 900 lbs.

Sizes: 2", 6" and 8".
Rating: 1500 lbs.

API (rectangular opening)
Sizes: 2", 3" and 4".
Rating: 600 lbs. and 900 lbs.
Size: 2"
Rating: 1500 lbs.

Temperatures: 225° F. max., minus 30° F. min.

Give us a call if you want to make LPG valving a problem of the past.

Cameron
IRON WORKS, INC.
P. O. Box 1212 - Houston, Texas

Export Office: 7912 Empire State Bldg., New York City. In England: Cameron Iron Works Ltd. Time & Life Bldg., New Bond Street, London W. 1 England.

In your gas-scrubbing processes... Call on JEFFERSON

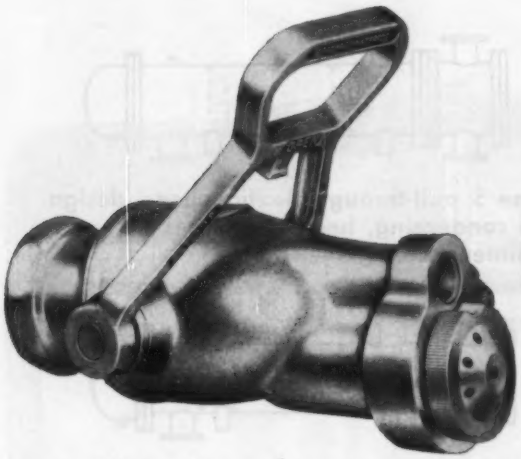
Pipelines directly into your plant, with glycols and ethanolamines available at the turn of a valve! A nice "pipe dream" for the purchasing and plant personnel! Next best is Jefferson service in tank cars, tank wagons and drums from convenient distribution points at Port Neches and Houston, Texas; Chicago; Charlotte; Los Angeles; and Tenafly, N. J.

These high-quality gas-scrubbing chemicals are backed by the knowledge and experience of our technical staff. For prompt service, just call your nearest Jefferson office. **Jefferson Chemical Company, Inc., Box 303, Houston 1, Texas.**

Essential Chemicals from Hydrocarbon Sources

Jefferson
CHEMICAL COMPANY, INC.

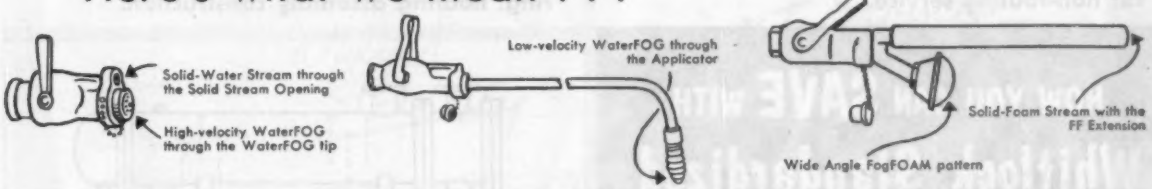
HOUSTON · NEW YORK · CHICAGO · CLEVELAND · CHARLOTTE · LOS ANGELES



Rockwood SG-60 WaterFOG Nozzle is five nozzles in one

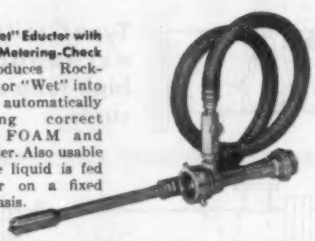
The lightweight Rockwood SG-60 WaterFOG Nozzle *eliminates "special" or single-purpose nozzles!* It actually does the work of five nozzles to put out fires faster, safer and more economically.

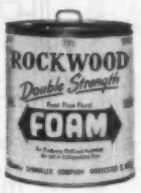
Here's what we mean . . .


Solid-Water Stream through the Solid Stream Opening
High-velocity WaterFOG through the WaterFOG tip
Low-velocity WaterFOG through the Applicator
Solid-Foam Stream with the FF Extension
Wide Angle FogFOAM pattern

Here's what you need to put out ordinary combustibles and flammable liquids . . .

FOAM and "Wet" Eductor with the new FW Metering-Check Valve. Introduces Rockwood FOAM or "Wet" into hose lines, automatically proportioning correct amount of FOAM and "Wet" to water. Also usable wherever one liquid is fed into another on a fixed percentage basis.



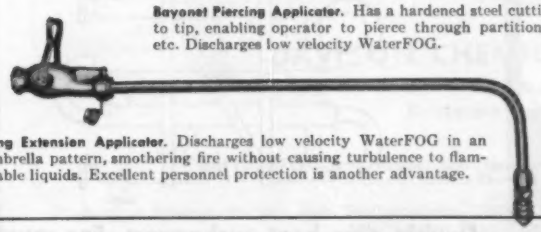


Rockwood Double Strength FOAM. Puts out fires in flammable liquids, and in ordinary combustibles, quicker, at lower cost. Three parts FOAM and 97 parts water create a heat-resistant blanket.

Rockwood WET. One part WET mixed with 99 parts water increases water's penetration and extinguishing action. Gives quickest results against deep seated fires. Saves time, water, manpower.

FF Extension Unit. Shown with Type SG-60 Nozzle. Discharges Rockwood FOAM in a solid stream or as FogFOAM. Wide angle makes it possible to cover large areas at one time.

Bayonet Piercing Applicator. Has a hardened steel cutting tool attached to tip, enabling operator to pierce through partitions, into interiors, etc. Discharges low velocity WaterFOG.



Long Extension Applicator. Discharges low velocity WaterFOG in an umbrella pattern, smothering fire without causing turbulence to flammable liquids. Excellent personnel protection is another advantage.

ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses

Distributors in all principal industrial areas

and here's the way to get more information

ROCKWOOD SPRINKLER COMPANY

Portable Fire Protection Division
1609 Harlow Street
Worcester 5, Massachusetts

Please send me your illustrated booklet on Rockwood fire-fighting products.

Name .....

Title .....

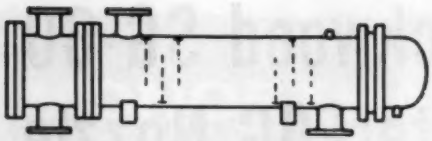
Company .....

Street .....

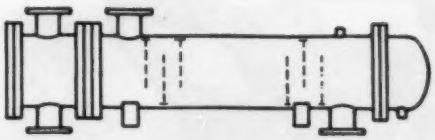
City .....

Zone ..... *State* .....

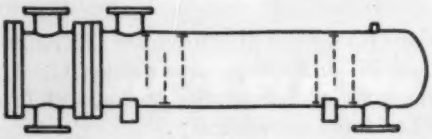
For more data on advertised products, use Readers' Service Cards, last page.



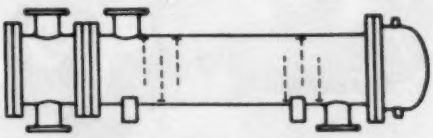
Type SG straight tube, outside packed lantern gland design. Eliminates undetected fluid inter-leakage.



Type S pull-through floating head design. For condensing, heating services . . . easy maintenance.

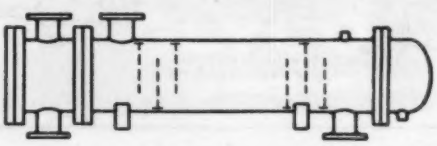


Type R U-tube design. Low cost construction, for non-fouling service.



Type ST conventional straight tube, split ring, floating assembly construction.

HOW YOU CAN SAVE WITH Whitlock Standardized Heat Exchangers!



Straight tube, fixed tube sheet design. Types V and V-1—for easy mechanical cleaning.

SAVE WORK . . . "prints for approval" can be supplied quickly for piping and other layouts.

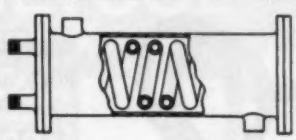
SAVE ENGINEERING COSTS . . . our engineers will help you select a standard design suited to your requirements.

SAVE DELIVERY TIME . . . many units can be manufactured promptly from stock materials and subassemblies. Also, completed units are often in stock for immediate shipment.

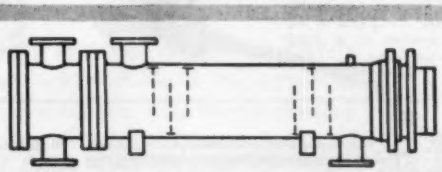
SAVE ON REPAIRS . . . readily available duplicate parts simplify emergency repairs . . . reduce downtime.

SAVE ON FIRST COSTS . . . our long manufacturing experience plus quantity produced sub-assemblies and quantity purchasing of materials reduce the unit cost of Whitlock Standard Exchangers. These savings are reflectea in our current prices.

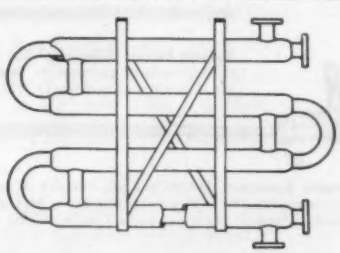
Compare costs . . . compare *savings*. It pays to consider Whitlock Standard Exchangers *first*. Send for Bulletin 250. The Whitlock Manufacturing Co., 75 South St., West Hartford 10, Conn.



Type C coil type heat exchangers. For high tube side pressures.



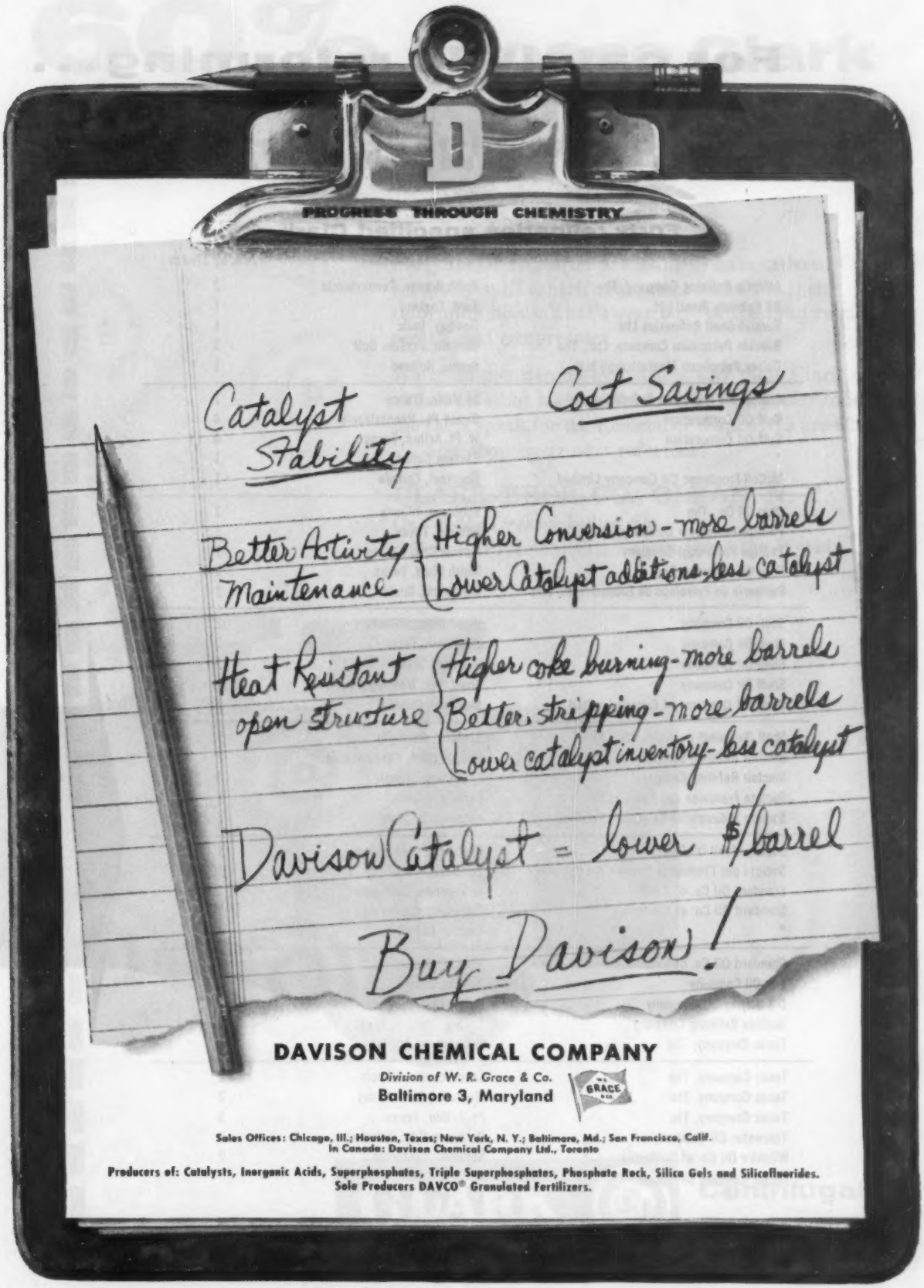
Floating head heat exchangers. Type SO with outside packed head—no concealed, bolted and gasketed joints.



Double pipe heat exchangers. For countertemperature flow conditions and low flow rates.

Whitlock

Designers and builders of bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers.



DAVISON CHEMICAL COMPANY

Division of W. R. Grace & Co.

Baltimore 3, Maryland

Sales Offices: Chicago, Ill.; Houston, Texas; New York, N. Y.; Baltimore, Md.; San Francisco, Calif.
In Canada: Davison Chemical Company Ltd., Toronto

Producers of: Catalysts, Inorganic Acids, Superphosphates, Triple Superphosphates, Phosphate Rock, Silica Gels and Silicofluorides.
Sole Producers DAVCO® Granulated Fertilizers.

For catalytic reforming...

Forty refineries specified Clark

User	*Location*	*No. of Units*
Atlantic Refining Company, The	Point Breeze, Pennsylvania	2
BP Refinery (Kent) Ltd.	Kent, England	1
Burmah-Shell Refineries Ltd.	Bombay, India	1
Bahrain Petroleum Company, Ltd., The	Bahrain, Persian Gulf	1
Caltex Petroleum Maatschappij N.V.	Pernis, Holland	1
Compagnie Francaise de Raffinage	La Mede, France	1
Gulf Oil Corporation	Girard Pt., Pennsylvania	4
Gulf Oil Corporation	W. Pt. Arthur, Texas	4
*	Eastern Canada	1
McColl-Frontenac Oil Company Limited	Montreal, Canada	1
Ohio Oil Co., The	Robinson, Illinois	1
Phillips Petroleum Company	Phillips, Texas	1
Phillips Petroleum Company	Kansas City, Kansas	1
Pure Oil Company, The	Smith Bluff, Texas	1
Refineria de Petroleos de Escombreras, S.A.	Cartagena, Spain	2
Shell Oil Company	Wood River, Illinois	2
Shell Oil Company	Deer Park, Texas	1
Shell Oil Company	Houston, Texas	2
Shell Oil Company	Anacortes, Washington	1
Shell Oil Company of Canada Limited	Montreal, Canada	1
Shell (Refining) Australia Pty. Ltd.	Geelong, Australia	1
Sinclair Refining Company	Marcus Hook, Pennsylvania	2
Sinclair Refining Company	E. Chicago, Illinois	2
Societe Francaise des Petroles BP	Dunkirk, France	1
Societe Industrielle Belge des Petroles	Antwerp, Belgium	1
Socony Mobil Oil Company, Inc.	Paulsboro, New Jersey	1
Societe per l'Industria Italiana del Petrolio	La Spezia, Italy	1
Standard Oil Co. of California	El Segundo, California	2
Standard Oil Co. of California	Richmond, California	2
*	Central Kansas	1
Standard Oil Co. of Ohio	Toledo, Ohio	2
Sun Oil Company	Toledo, Ohio	1
D-X Sunray Oil Company	Tulsa, Oklahoma	1
Suntide Refining Company	Corpus Christie, Texas	2
Texas Company, The	Wilmington, California	1
Texas Company, The	Laurenceville, Illinois	2
Texas Company, The	Westville, New Jersey	2
Texas Company, The	Pt. Arthur, Texas	5
Tidewater Oil Company	Delaware City, Delaware	1
Wilshire Oil Co. of California	Norwalk, California	2

*Name furnished on request

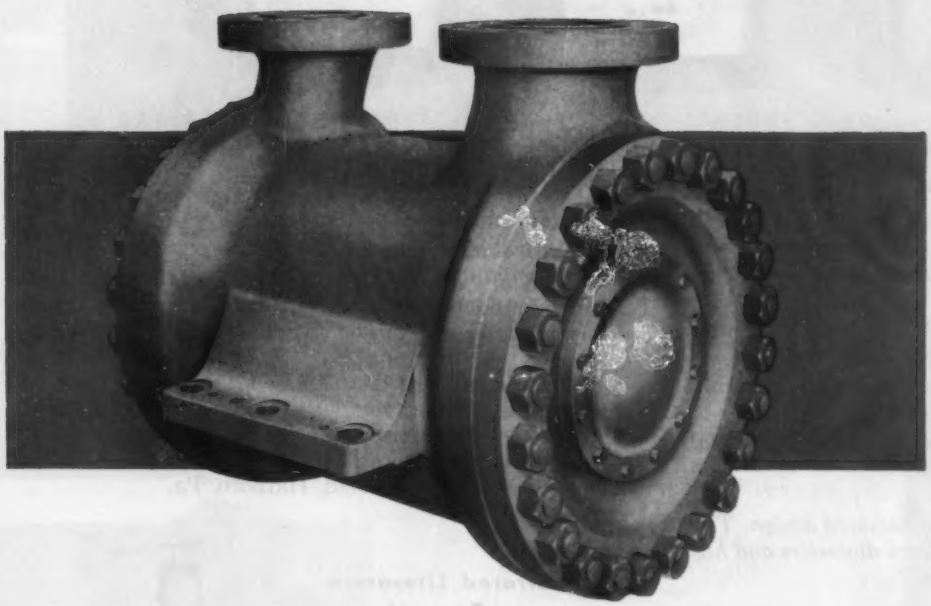
60% choose Clark

Vertically-split centrifugal compressors

Forty major refineries are using or have ordered Clark vertically-split centrifugal compressors for their reforming needs. That's over 60% of the total requiring centrifugal compressors.

We could mention many reasons why these Clark units outsell all other makes combined, but we prefer to let the facts speak for us. Remember 6 out of 10 are Clark . . . how about your next reformer?

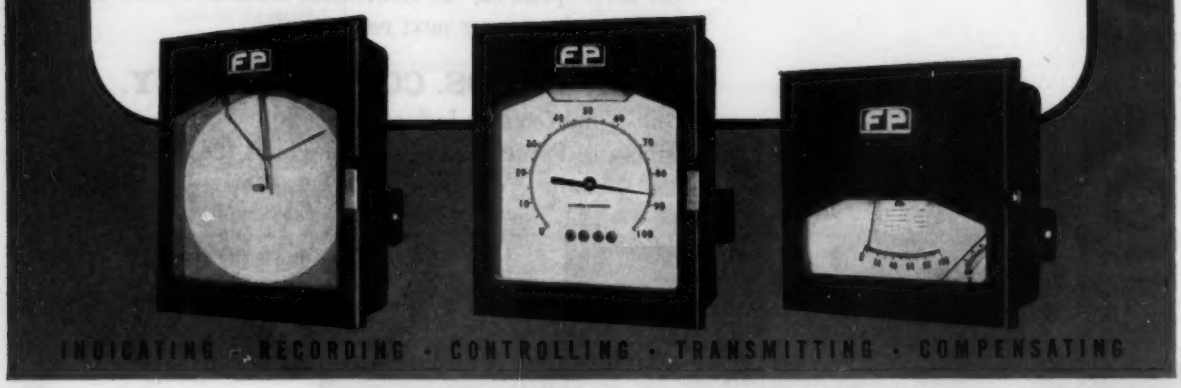
CLARK BROS. CO., OLEAN, N. Y.
One of the Dresser Industries
Offices in Principal Cities throughout the World



CLARK® Centrifugal Compressors

For more data on advertised products, use Readers' Service Cards, last page.

What makes these temperature instruments sell?



FISCHER & PORTER temperature instruments sell. We can't tell you *all* the reasons why, but we *know* instrument men order them again and again.

It must be their reliability. It must be their accuracy. It must be their quick response.

All of these things and more are built into F&P temperature instruments.

Check the many advantages you get with F&P instruments:

Fast response *because of balanced design. Thin wall bulbs, internal capillary diameters and high filling pressure make it so.*

High Sensitivity

For any application *between minus 400°F and plus 1000°F.*

Linear output *in all liquid and gas filled systems.*

Positive *over-range and under-range protection.*

Up to four pens *in one instrument.*

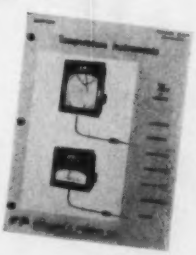
Dual control instruments, *with all accessories enclosed within the case.*

Stainless steel parts, *controller adjustments easily accessible, all controller options available.*

Even in the smallest details Fischer & Porter engineering provides you with the best answer to your instrument needs. Write for complete details or specific quotations. Fischer & Porter Co., 927 County Line Road, Hatboro, Pa.

Illustrated Literature on Request

Catalog 12-A-10 provides complete engineering specifications on F&P Temperature Instruments. A copy is free for the asking. Write now.



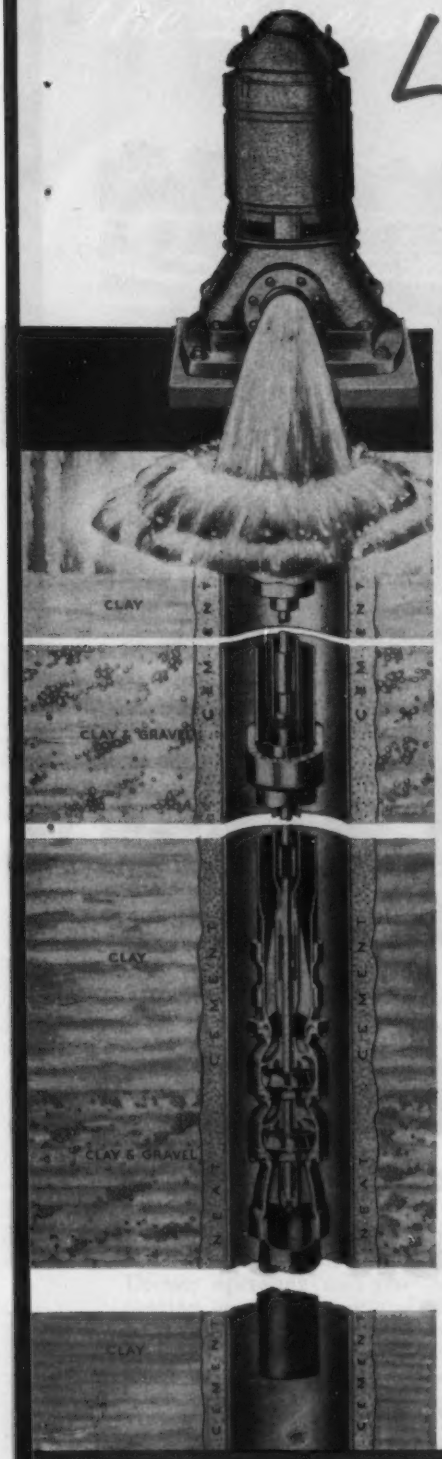
FP FISCHER & PORTER CO. Hatboro, Pa.

COMPLETE PROCESS INSTRUMENTATION

For more data on advertised products, use Readers' Service Cards, last page.

LA1142

Layne knows more about water bearing formations!



On whose say-so? Not on ours—but on the experience of scores of American and foreign firms and municipalities whose very existence and success depend on an adequate supply of water.

Knowing where the water is — and then tapping the subterranean source is but a part of the vast knowledge the Layne organizations have accumulated in three quarters of a century.

Once the source is determined and the water supply developed, a dependable means for delivering the water must be provided, and that's where the famous Layne pump comes in. For each Layne pump is specifically engineered for the particular job. There is no "stock" Layne pump. Your pump is created for your job —making use of the knowledge of strata, water requirements and usage.

ENGINEERED, DEPENDABLE PERFORMANCE IS WHAT YOU GET WHEN LAYNE DOES THE JOB — COMPLETE FROM WATER LOCATION TO YEAR AFTER YEAR OF TROUBLE-FREE PUMPING.

YOUR NEXT WELL AND PUMP INSTALLATION MAY BE MONTHS OFF. GET TO KNOW THE LAYNE FOLKS IN YOUR AREA. SAVE TIME AND MONEY THROUGH THEIR INTIMATE KNOWLEDGE OF WATER.

Send now for our general services bulletin No. 100.

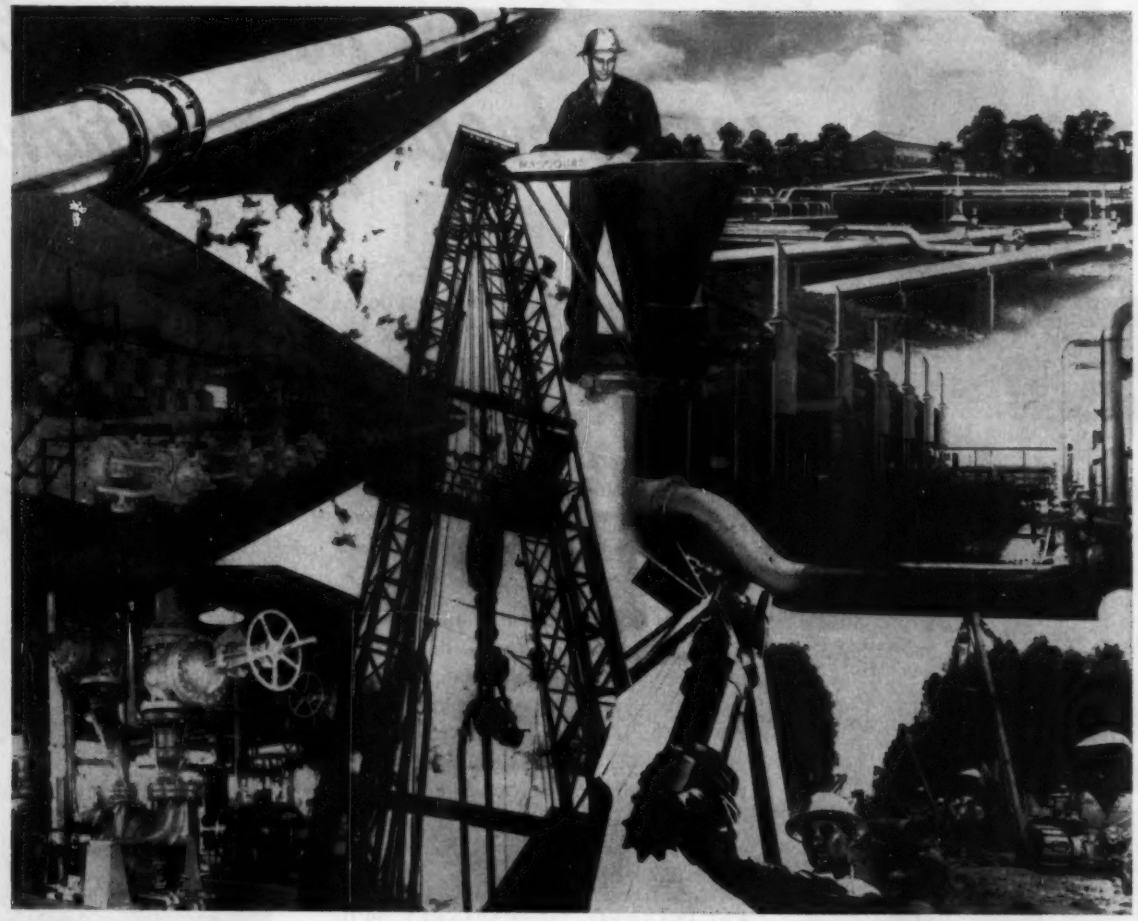
1882 — 1957
Layne
75 YEARS OF PROGRESS

WATER WELLS • VERTICAL TURBINE PUMPS • WATER TREATMENT

LAYNE & BOWLER, INC. MEMPHIS

General Offices and Factory • Memphis 8, Tennessee

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD



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THE DRESSER INDUSTRIAL TEAM SERVES THE GROWING OIL

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CLARK BROS. CO., Olean, New York —Gas turbines, engines, and reciprocating, centrifugal and axial flow compressors—gas, steam, electric and diesel driven.

DRESSER IDECO

DRESSER-IDECO COMPANY, Columbus, Ohio—Radio and television broadcasting towers, steel buildings, aircraft hangars, electric power substations.

DRESSER MANUFACTURING DIVISION

DRESSER MANUFACTURING DIVISION, Bradford, Pa.—Pipe line couplings, pipe repair sleeves and clamps, weldments, forgings, welding fittings, flanges, rings.

SAFE THAN SORRY BETTER BE GUIBERSON

THE GUIBERSON CORPORATION, Dallas, Tex.—Swabs, packers, anchors, workover equipment—drilling heads, blowout preventers, tubing blocks, hooks, swivels, kellys, savers, unions. Gas lift equipment. Molded rubber products.

IDECO®

IDECO, Dallas, Tex.—Hydrair* and Power Rigs; Full-View* Masts; substructures; single, dual and Drive-In Rambler Rigs; blocks, swivels, rotaries; mud pumps; petroleum equipment and supplies.

LANE WELLS

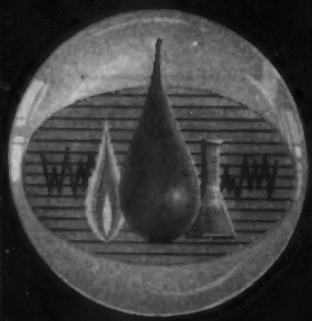
LANE-WELLS CO., Los Angeles, Calif., Houston, Tex., Oklahoma City Okla.—Electric and Radioactivity Well Logging, Koneshot* perforating and bullet perforating, packers and bridging plugs.

Magcobar.

MAGNET COVE BARIUM CORP., Houston, Tex.—Magcobar* and Magcogel* drilling muds and other specialized oil well drilling fluids and chemicals.

PACIFIC

PACIFIC PUMPS, INC., Huntington Park, Calif.—Centrifugal pumps for refineries, power stations, pipelines, and chemical plants; plunger pumps for oilwells.



ROOTS R C CONNERSVILLE SINCE 1854

ROOTS-CONNERSVILLE BLOWER DIVISION, Connersville, Ind.—Rotary positive blowers, gas pumps, centrifugal blowers, exhausters, vacuum pumps, and positive displacement meters.

Security

SECURITY ENGINEERING DIVISION, Dallas, Tex., Whittier, Calif.—Rock bits, reamer rock bits and hole openers; reamers, casing scrapers and Neo-Red rubber stabilizers.

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SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., Houston, Tex.—Seismograph systems and instruments—electronic, electro-mechanical. Computers—analog and digital; recording systems. Special transformers, reactors.

*Trademark registered

put this DRESSER *plus+* team to work for you!

You receive a bonus of extra value whenever you are served by any one of the Dresser companies. Each Dresser operating unit provides the research, engineering, manufacturing and service applications for its particular specialties. *All* work together to provide the combined experience and facilities of the world-wide Dresser industrial team. This inter-company teamwork offers a bonus in greater experience and technical knowledge – backed by the extensive Dresser facilities – in the customer's specific industry. This intangible but important factor is known throughout the world as the Dresser plus+ . . . the mark of superior equipment and services for the oil, gas, chemical, electronic, and general industry.

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GAS, CHEMICAL AND ELECTRONIC INDUSTRIES — *EVERYWHERE*

STAYNEW FILTERS

Dollinger makes ALL TYPES of filters as shown on this page, plus special filters for unusual filtration problems. New users of one specific type of Staynew filters often find a second Dollinger filter performs a great, added service in other processes or operations. Perhaps we can serve major or other filtration needs of your plant.

LIQUID FILTERS

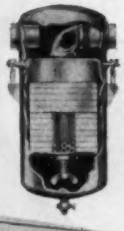
Model HE (Sump) Liquid Filter Bulletin 330

Model ELS (Pressure) Liquid Filter Bulletin 300

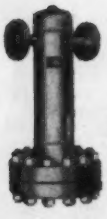
PIPE LINE FILTERS

Model CPH Pipe Line Filter Bulletin 200

Model CVH (Vacuum) Pipe Line Filter Bulletin 200



Model AAPHS (Absorption) Pipe Line Filter Bulletin 200



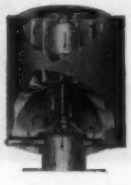
Model HPH and AHPH (High Pressure) Pipe Line Filter Bulletin 200

all types of FILTERS for every INDUSTRIAL NEED

AIR INTAKE FILTERS

Model IDR (Ground Level) Air Intake Filter Bulletin 100

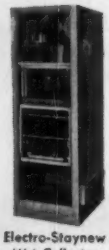
Model DS (Silencer) Air Intake Filter Bulletin 100



Model D (Outdoor) Air Intake Filter Bulletin 100

Model C (Indoor) Air Intake Filter Bulletin 100

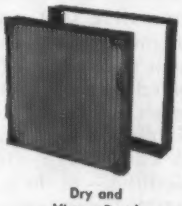
VENTILATION FILTERS



Electro-Staynew Mist Collector Bulletin 420

Electro-Staynew Precipitator Bulletin 400

Automatic Ventilation Filter Bulletin 500

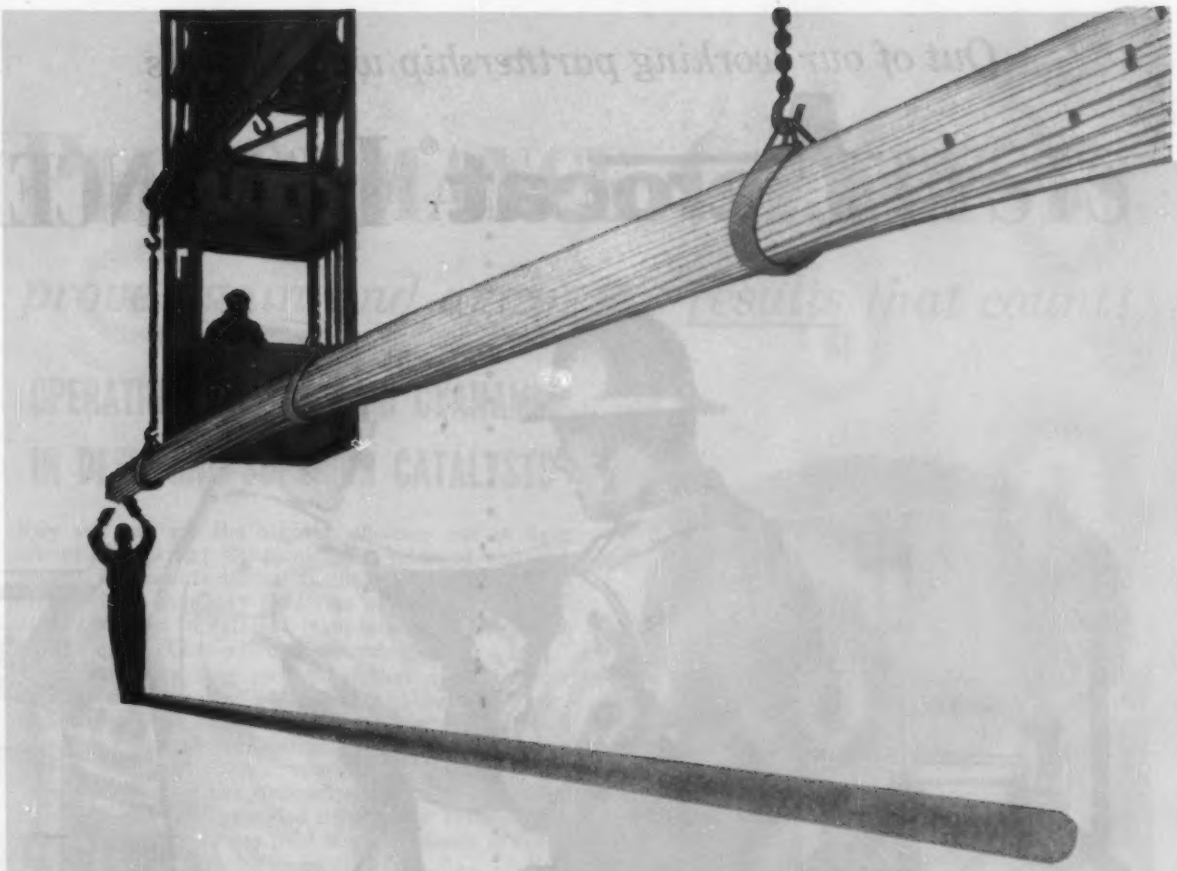


Dry and Viscous Panel Ventilation Filters Bulletin 600 and 700

DOLLINGER REG. PROTECTOMOTOR U.S. PAT. OFF. STAYNEW FILTERS

DOLLINGER CORPORATION CENTRE PK. ROCHESTER 3, N.Y.

Write, using Bulletin Numbers, for complete information on any of the Staynew filters illustrated. Consult Dollinger engineers on any special filtration problems—no obligation. Dept. 47 Centre Park, Rochester.



Here is the answer to your needs for **EXTRA LONG**

SEAMLESS STEEL TUBING

Pacific Tube Company can now supply you with precision, cold-drawn Seamless Steel Tubing in absolutely straight lengths up to 58 feet long. Special new equipment, including new pickling tanks 60 feet long makes this feat possible. The longest draw bench in the country helps, too!

For your protection and better tubing, new high-pressure hydrostatic testing is used.

A wide range of sizes is quickly available in many chemistries in Stainless, Seamless Carbon and Alloy Tubing... cold-drawn to your exact specifications.

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COLD-DRAWN BARS
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Precision drawn to rigid specifications from 3/16" thru 3½" in many chemistries including Ledloy Grades A & B.

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TUBE COMPANY

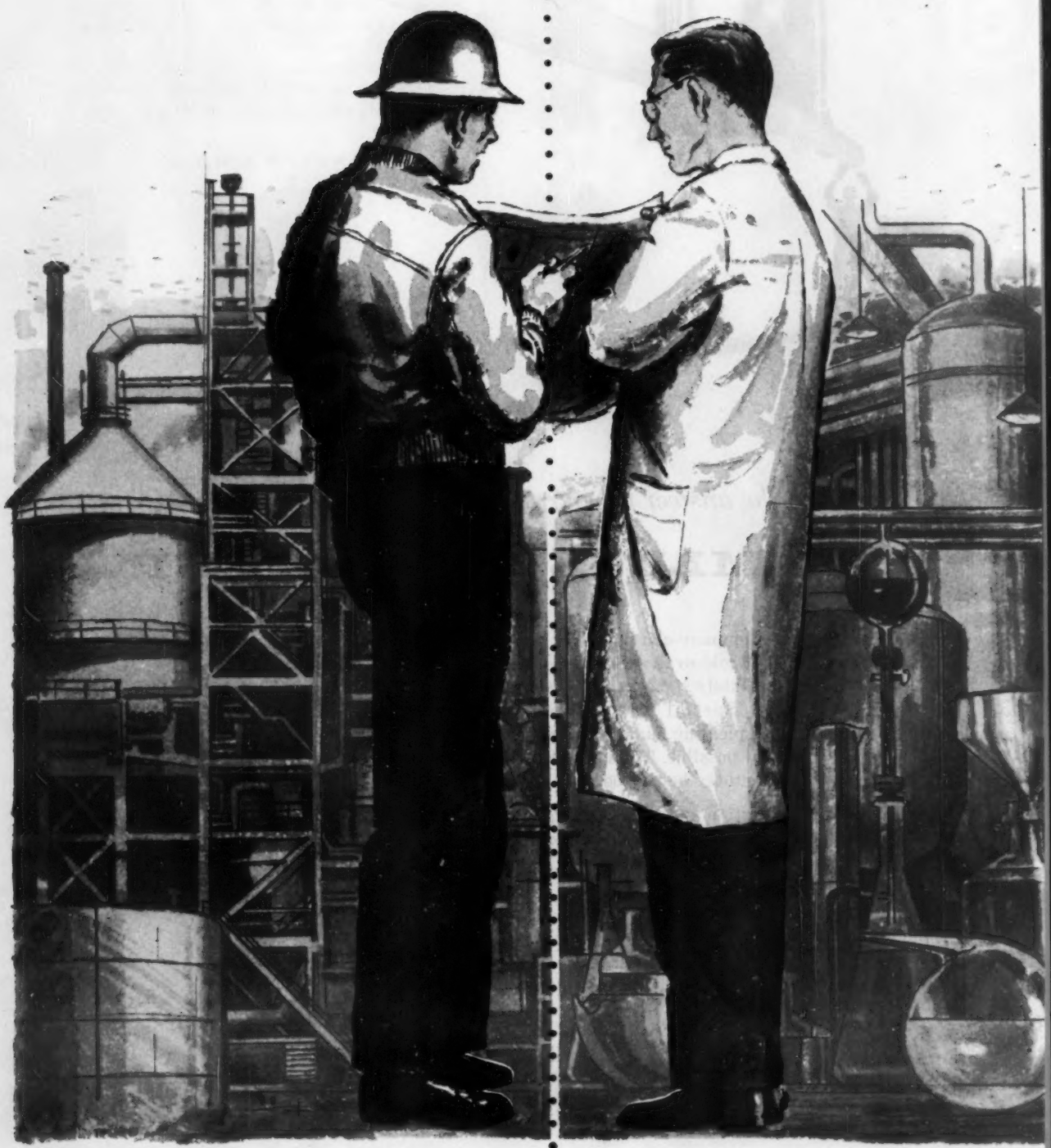
5710 Smithway St., Los Angeles 22, Cal.

MANUFACTURERS OF SEAMLESS STEEL TUBES • BAR STOCK • GROUND & POLISHED SHAFTING

For more data on advertised products, use Readers' Service Cards, last page.

Out of our working partnership with refiners

Aerocat® BALANCED



PERFORMANCE CATALYSTS

prove again and again it's results that count!

OPERATING REFINERS AID CYANAMID IN DESIGNING SUPERIOR CATALYSTS

Now you can get the highest efficiency yet in fluid catalytic cracking! Cyanamid has enlarged and improved its manufacturing facilities for regular and high-alumina AEROCAT Catalysts as a result of technical advances in catalyst manufacture developed at its Stamford, Connecticut Research Center.

Refiners have long recognized that no one factor dominates in catalyst performance. Cyanamid's consistent objective has been to bring every variable in catalyst properties into balance for peak performance under varying refinery operating conditions. Our development work has always been based on operating and research data provided directly by refiners . . . a cooperation which has paid large dividends in cracking efficiency.

New equipment developed by Stamford Research contributes to a unique manufacturing process, governed at every production stage by rigid laboratory-checked controls. This enables us to maintain commercial production at research quality standards.

Your evaluation of the new AEROCAT Catalysts is invited. Our technical service and research staffs will do their best to help you get on stream to greater productivity.

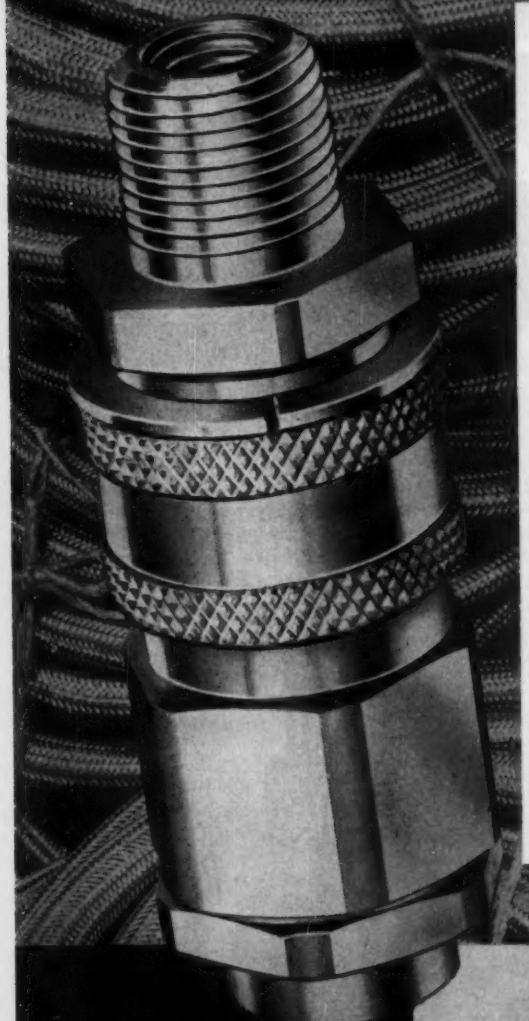
Unique vapor phase chromatography apparatus developed by our Stamford Research Center automatically identifies volatile organic liquids. Apparatus permits rapid evaluation of catalyst efficiency at the refinery or under laboratory conditions. It is typical of the highly specialized equipment used at Stamford for catalyst research.

Again, it's *results* that count—and the relative importance of *all* catalyst properties has been under exhaustive research in laboratories of Cyanamid and its customers. In this way, AEROCAT Catalysts have been improved to give refiners highest cracking efficiency.

AMERICAN CYANAMID COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N. Y.
In Canada: North American Cyanamid Limited, Toronto and Montreal

For more data on advertised products, use Readers' Service Cards, last page.

Now Available



through Local Distributors . . .

Perfectly Paired METAL HOSE* *and* Quick-Seal COUPLINGS

Titeflex hose and couplings solve some of industry's most vexing conveyance problems. Handle flow of organic and volatile liquids as well as gases, between moving or misaligned terminals, at wide extremes in temperatures and pressures. Also absorb vibration, pulsation and shock. Couplings couple and uncouple in ONE second . . . are leak-proof at all operating pressures.

Hose sizes: 3/16" to 3" Coupling sizes: ¼" to 12"

**Other tough conveyance problems are solved with Titeflex flexible hose made of* TEFLON*—a Du Pont tetrafluoroethylene resin—in sizes of ¼" to 1¼"*

CALL YOUR LOCAL DISTRIBUTOR

Consult the yellow pages of your telephone directory

Your one source for both Hose and Couplings

Titeflex

TITEFLEX, INC., 600 HENDEE STREET, SPRINGFIELD 4, MASS.

For more data on advertised products, use Readers' Service Cards, last page.

Workman impales FOAMGLAS blocks on studs welded to surface of Mississippi Chemical's tank. FOAMGLAS was quickly and economically installed because it is light, strong, rigid and easily handled.

On large stainless steel tank for ammonium nitrate storage...

FOAMGLAS insulation stays dry, fights acid, cuts heating costs for Mississippi Chemical

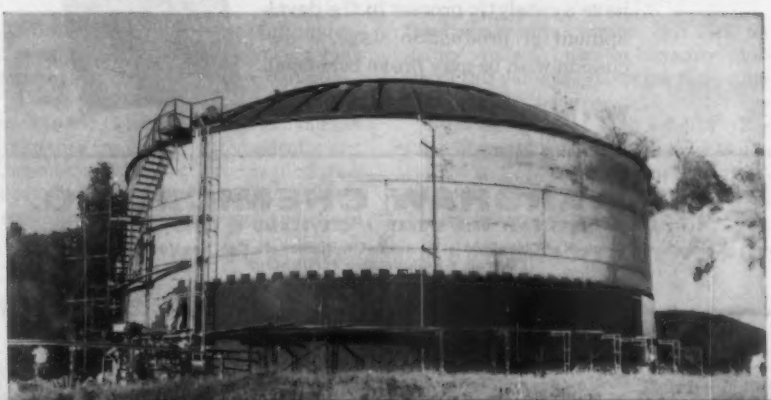
Inorganic FOAMGLAS tank insulation is helping Mississippi Chemical Corporation, Yazoo City, Mississippi, get a quick return on their bulk storage investment. Here's their report on how this unique insulating material makes possible low-cost efficient storage of an 83-95% solution of ammonium nitrate in a huge, new 25,000 bbl stainless steel tank:

"The stored solution must be held at 150° F to keep crystalline ammonium nitrate from 'salting out.' Economical heating of the solution calls for dependable insulation on the tank . . . but ammonium nitrate or nitric acid will attack ordinary insulations. FOAMGLAS solved our problem because it is composed entirely of glass, making it impervious to acid attack. Since that glass forms a nonporous structure of sealed cells — each a separate insulating unit — moisture can't penetrate it to reduce its insulating effectiveness."

Mississippi Chemical concludes: "We get insulation that never varies in effectiveness. That gives us continual heating economy. A reserve of ammonium nitrate solution is readily available for high demand seasons. In effect, productive capacity is increased, and that makes for quick return on our storage investment."

Whatever *your* tank, equipment, piping or building insulation problem, you, too, can solve it best with FOAMGLAS. Its unique combination of properties can't be matched by any other insulating material. You can prove it to yourself with a series of simple tests, easily performed in your own office. Send today for a free FOAMGLAS sample and complete testing directions. Address ...

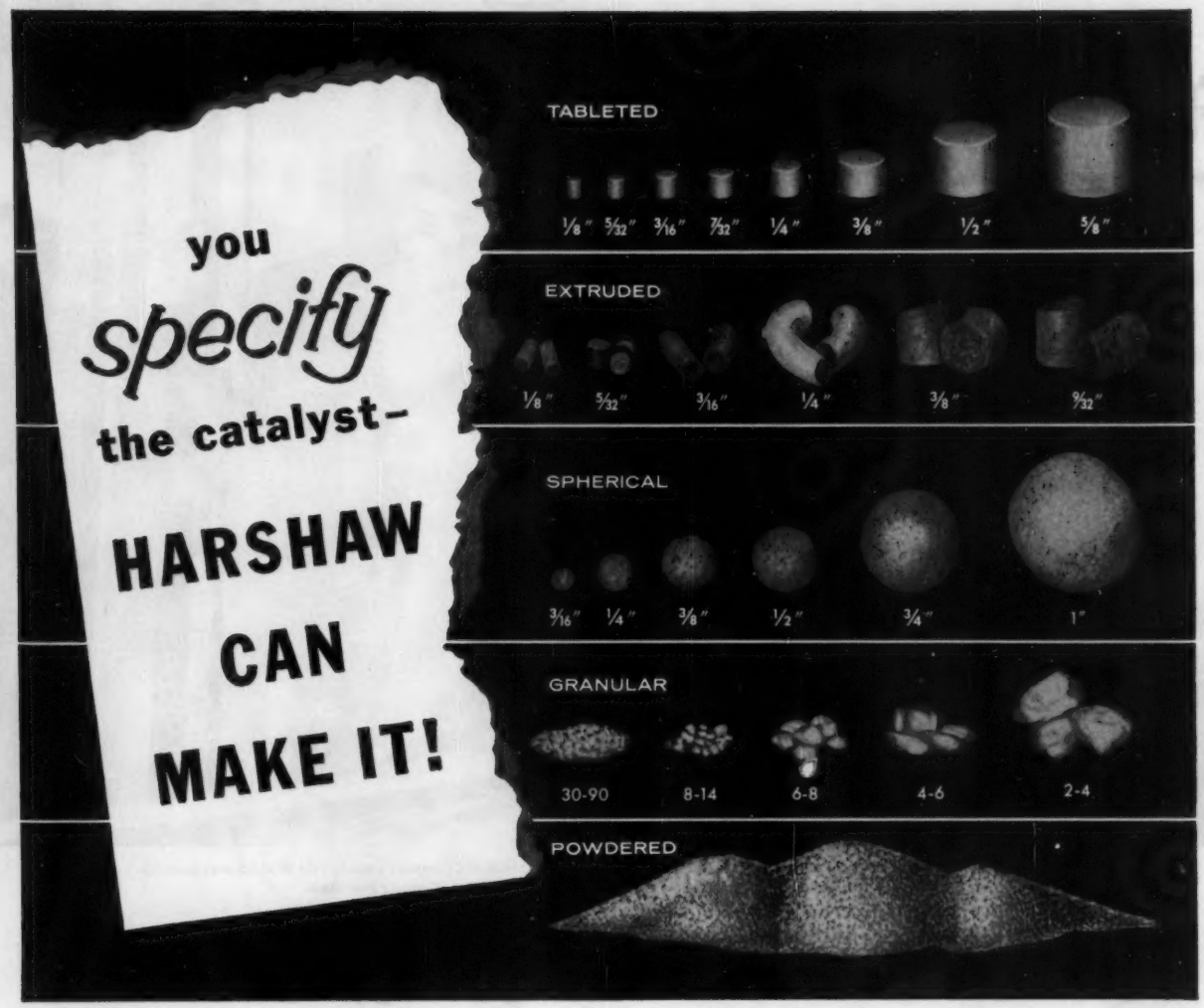
The heating economies insured by acid-proof FOAMGLAS insulation are helping to guarantee a quick return on Mississippi Chemical's investment in ammonium nitrate storage.



Pittsburgh Corning Corporation

Dept. Z-27, One Gateway Center
Pittsburgh 22, Pennsylvania
In Canada: 57 Bloor St. W., Toronto, Ontario

PC ® **Also manufacturers of PC Glass Blocks**



HARSHAW

has the facilities for producing carload quantities of

PREFORMED CATALYSTS

to fit special process requirements

Hydroforming	Dehydration
Cyclization	Desulphurization
Oxidation	Alkylation
Dehydrogenation	Isomerization

Hydrogenation

CATALYTIC CHEMICALS SUPPLIED BY HARSHAW

Aluminum Nitrate		Cobalt Nitrate
Copper Nitrate		Manganese Nitrate Solution
Metallic Soaps (Cobalt, Manganese)		
Nickel Carbonate	Nickel Formate	Nickel Nitrate
Nickel Sulfate	Sodium Methoxide	Zinc Nitrate

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

Write for FREE Booklet, "HARSHAW CATALYSTS"

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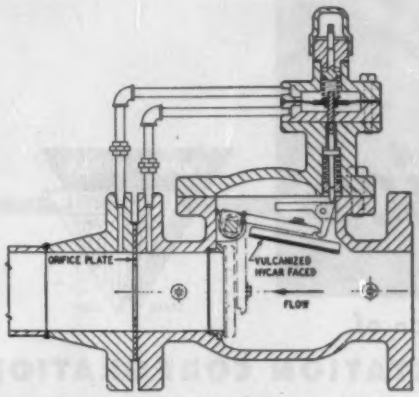
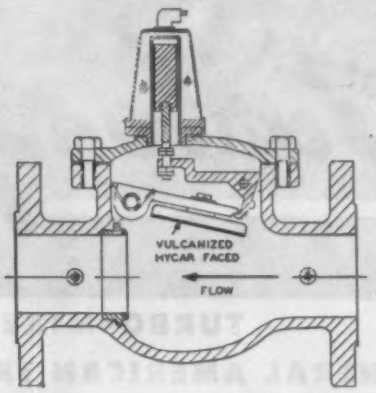
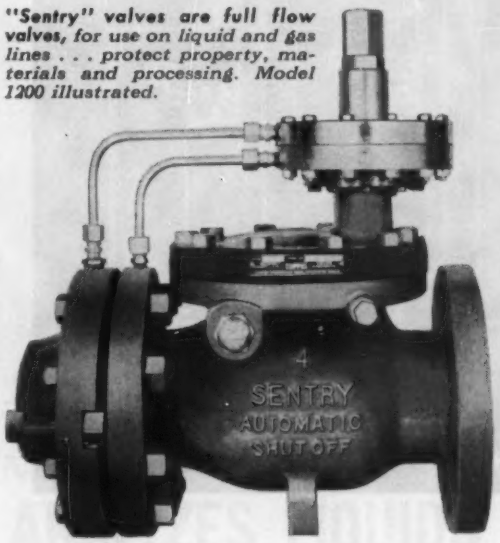


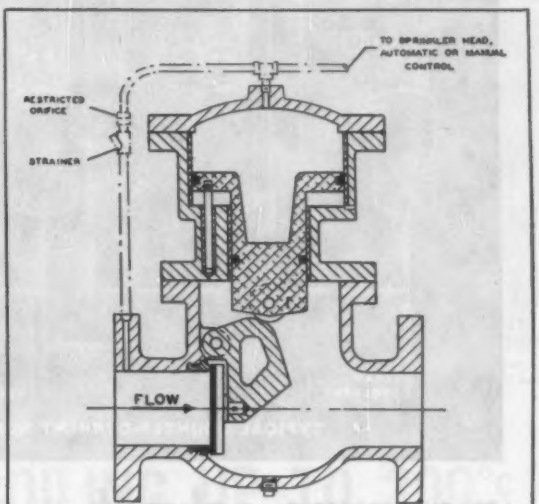
Model 1200. "Sentry" ***excess flow valve*** *automatically and instantaneously shuts off when the rate of flow in the line exceeds a predetermined rate.*



Models 1700 and 1800 "Sentry" ***solenoid shut-off valves*** *operate by remote electrical control automatically and instantaneously. In Model 1700, solenoid is energized, in Model 1800 solenoid is de-energized to maintain flow.*

"Sentry" valves are full flow valves, *for use on liquid and gas lines . . . protect property, materials and processing. Model 1200 illustrated.*





Model 3000 "Sentry" ***piston operated quick-opening valve*** *opens instantaneously when the pressure above piston is released. Ideal for deluge systems — and for remote opening and closing of fuel line.*

Other types "Sentry" Valves: high-pressure and low-pressure and over temperature shut-off valves available.

Now Coppus brings you "Sentry"® Valves for automatic protection

These valves are *patented* quick-closing latch type and quick-opening piston type. All are full flow valves.

Latch-type "Sentry" valves are widely used in the chemical, petroleum and gas industries for closing automatically and instantaneously gas, process and fuel lines. The piston type valve can be automatically or manually opened and closed from any remote location. It is ideal for deluge systems, operates instantly; closing of this valve is against the flow, eliminating water hammer.

Sizes run from 1½" to a full 8". For full information send for Coppus Bulletin 500 to Coppus Engineering Corporation, 415 Park Avenue, Worcester 2, Massachusetts.

ANOTHER
COPPUS
"BLUE RIBBON" PRODUCT

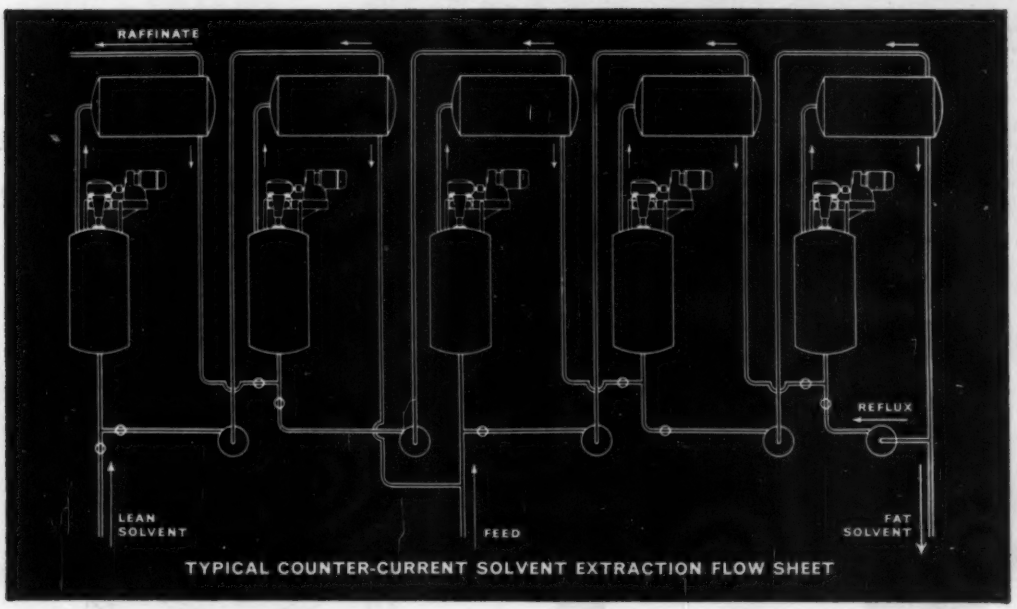
LOOK FOR THE BLUE BAND THAT IDENTIFIES COPPUS QUALITY

For more data on advertised products, use Readers' Service Cards, last page.

Turbo-Topics

TURBO-MIXER GENERAL AMERICAN TRADE MARK

TURBO-MIXER, a division of
GENERAL AMERICAN TRANSPORTATION CORPORATION



TYPICAL COUNTER-CURRENT SOLVENT EXTRACTION FLOW SHEET

maximum solvent extraction efficiency with TURBO on the job

Whether you are extracting uranium (like Kerr-McGee and Vitro) or butadiene (like Esso Standard or Polymer Corporation), there's a Turbo-Mixer designed exactly to meet your needs.

Turbo-Mixers are designed for maximum service, based on over 40 years of experience and specialization in mixer construction. Each and every Turbo-Mixer is ruggedly-built for continuous round-the-clock operation. This built-in performance assures you of peak efficiency, "headache-free" production, and lower costs in the long run. For descriptive information showing how your problems may be solved by Turbo-Mixer, write today.

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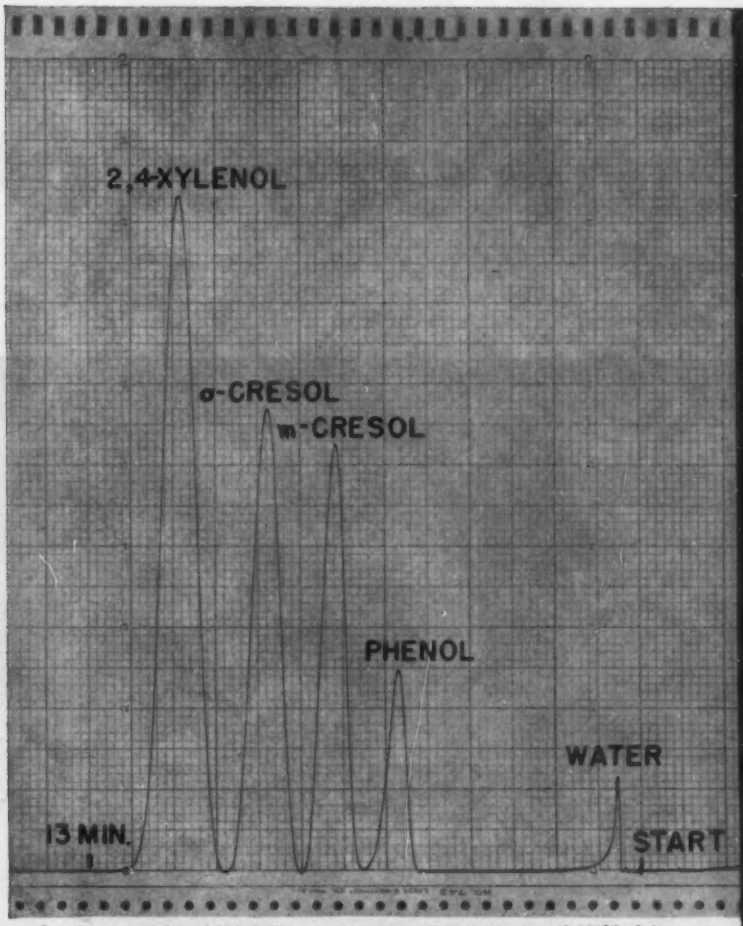
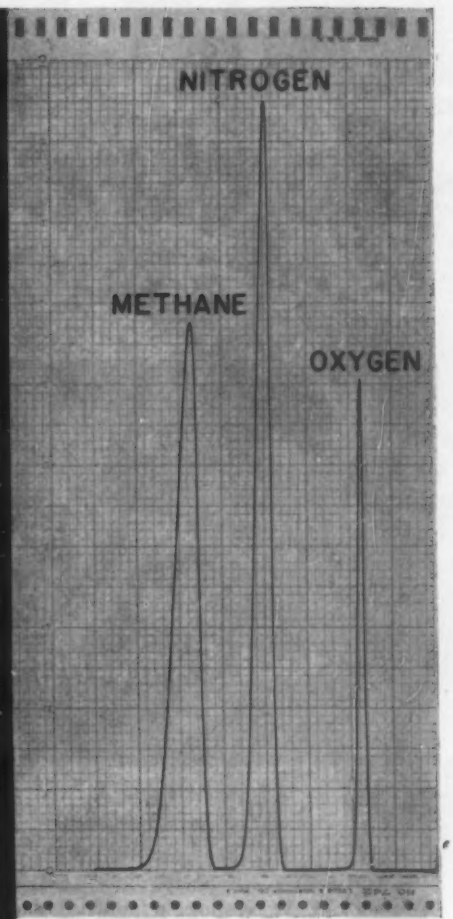


Run shows separation of high boiling components at column temperature of 190°C. 2,4-xylenol which boils at 211°C is separated in 11 minutes. Good resolution of other components is obtained.



The above determination of methane in air took five minutes. Other light gases boiling below 20°C are rapidly separated.

New P-E Model 154-B Vapor Fractometer

ANALYZES LIQUIDS BOILING UP TO 300°C

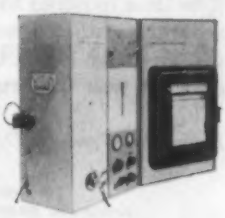
extends range of previous model by 50°

The fast, precise technique of gas chromatography can now be applied to the analysis of esters, cresols, phenols, xylenols, chlorinated aromatics and high alcohols boiling at 300°C or below with P-E's new Model 154-B Vapor Fractometer. Small laboratories just getting into gas chromatography work find it well suited to their needs while laboratories performing a high volume and wide range of chromatographic analyses can use the full range and versatility of the instrument. P-E's Vapor Fractometers are the most widely used gas chromatography instruments.

CHECK THESE FEATURES

- Continuously adjustable temperature control from 20°C to 225°C.
- Most sensitive dual thermal conductivity detector available with a detectability reaching 1 part in 100,000.
- Precise recorder range control in steps of 2 over range of 1 through 512 for accurate trace and high concentration analysis.
- Reproducible liquid (and gas) sampling accessory for introduction of exact sample volume.
- Reproducible gas sampling valve.*
- Sample collection outlet necessary for collecting eluted pures for reuse or identification by auxiliary methods such as infrared, ultraviolet, or mass spectroscopy.

*U.S. Patent No. 2,757,541



Write for the new 16-page booklet on the Model 154-B, including sampling features and performance runs of ten different column materials.

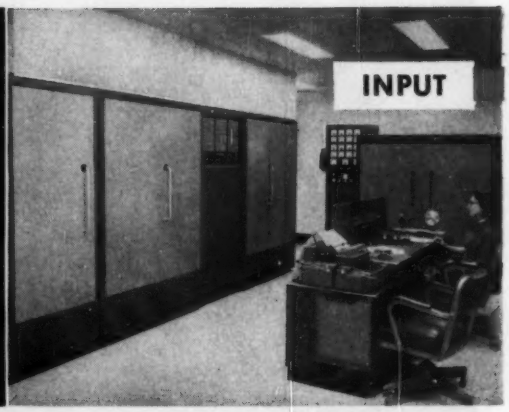
INSTRUMENT DIVISION

Perkin-Elmer *Corporation*

NORWALK, CONNECTICUT

Electronic Route to

Super-Speed Computer Minimizes Heat Transfer Surface Requirements of Heat Exchangers . . .



Control section of Kellogg's computer

IN DESIGNING heat-pressure process equipment, the addition of a large magnetic drum digital computer to M. W. Kellogg's facilities enables the company's engineers to study variables and produce results with unprecedented thoroughness, accuracy, and speed. Human error is practically eliminated.

To Kellogg's customers in the petroleum and chemical industries, this new electronic aid means that Kellogg engineers can devote more time to basic design problems, and provide equipment with maximum operating efficiency, minimum maintenance costs, and the lowest possible initial investment.

In the case of heat exchangers, for example, design calculations require a trial and error solution. The time required to do this with hand calculations seldom permitted several design alternates. Thus the engineer never could be sure that the design selected was the true optimum. With high speed electronic computation, however, the greater number of alternates economically possible now brings the ultimate or near ultimate design to every Kellogg customer.

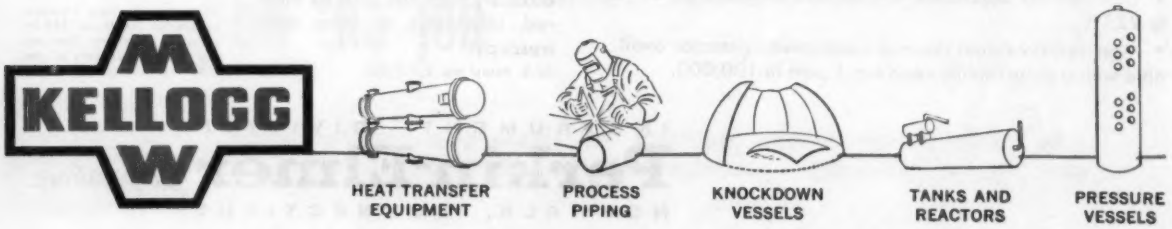
In one instance recently, involving 37 heat exchanger shells, the greater number of calculations achieved with the electronic computer resulted in reducing total heat transfer surface requirements by more than 15% from estimated values. Without the computer, the time required to obtain this value would have outweighed the saving many times, and would have been prohibitive.

Kellogg welcomes the opportunity to put its electronic computer and other engineering facilities to work for you. Arrangements to see the computer in operation in Kellogg's New York office can be made by contacting the company's Fabricated Products Division.

Fabricated Products Division • THE M. W. KELLOGG COMPANY • 711 Third Avenue, New York 17, N. Y.

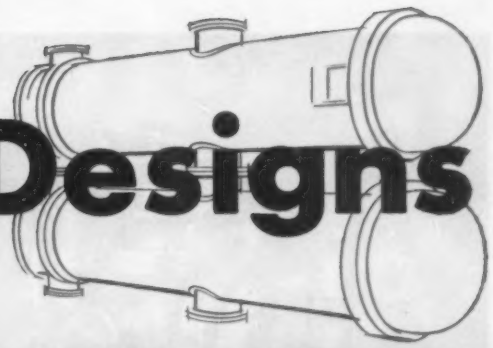
A SUBSIDIARY OF PULLMAN INCORPORATED

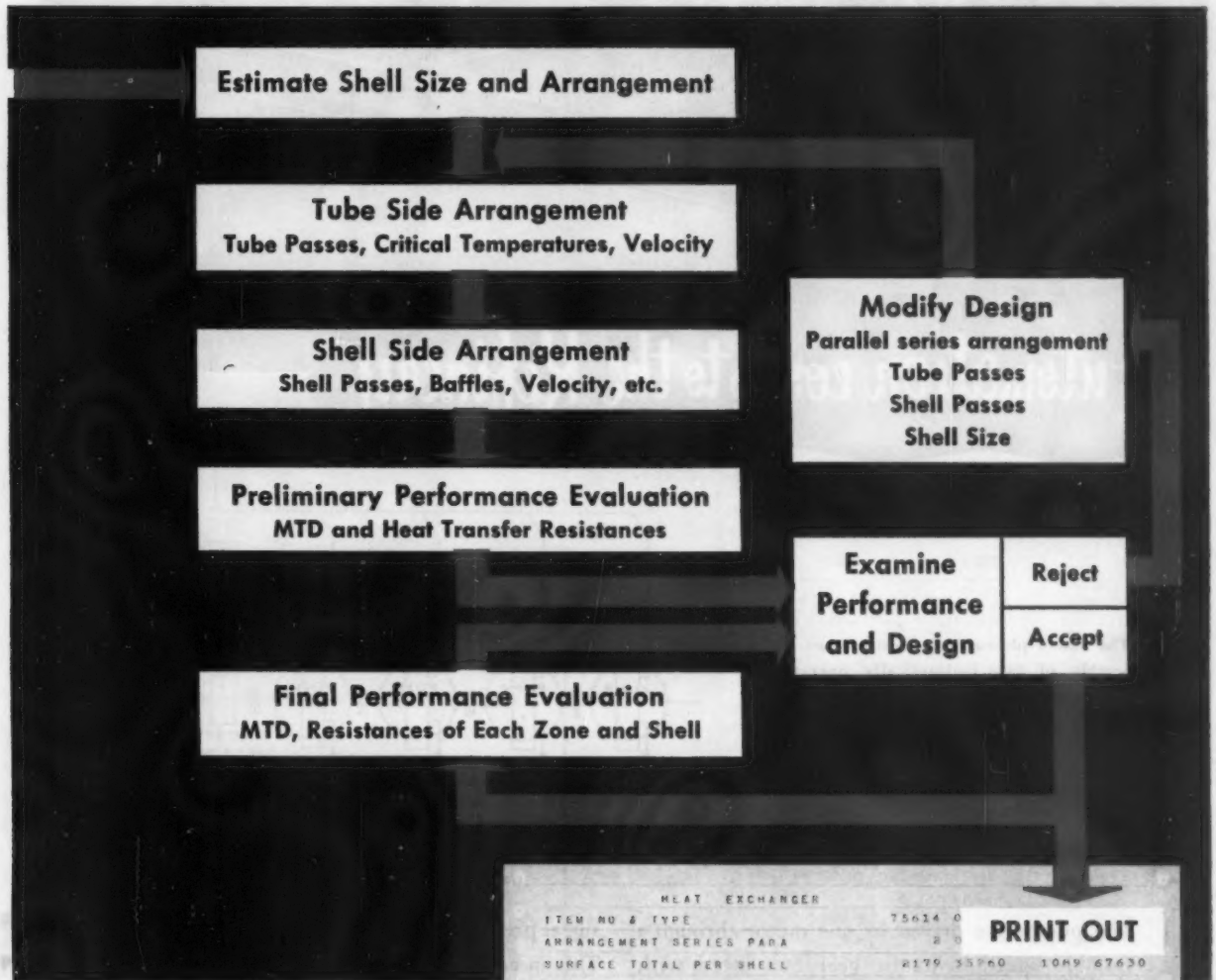
The Canadian Kellogg Company Limited, Toronto • Kellogg International Corporation, London • Societe Kellogg, Paris
Kellogg Pan American Corporation, New York • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas



For more data on advertised products, use Readers' Service Cards, last page.

Optimum Designs

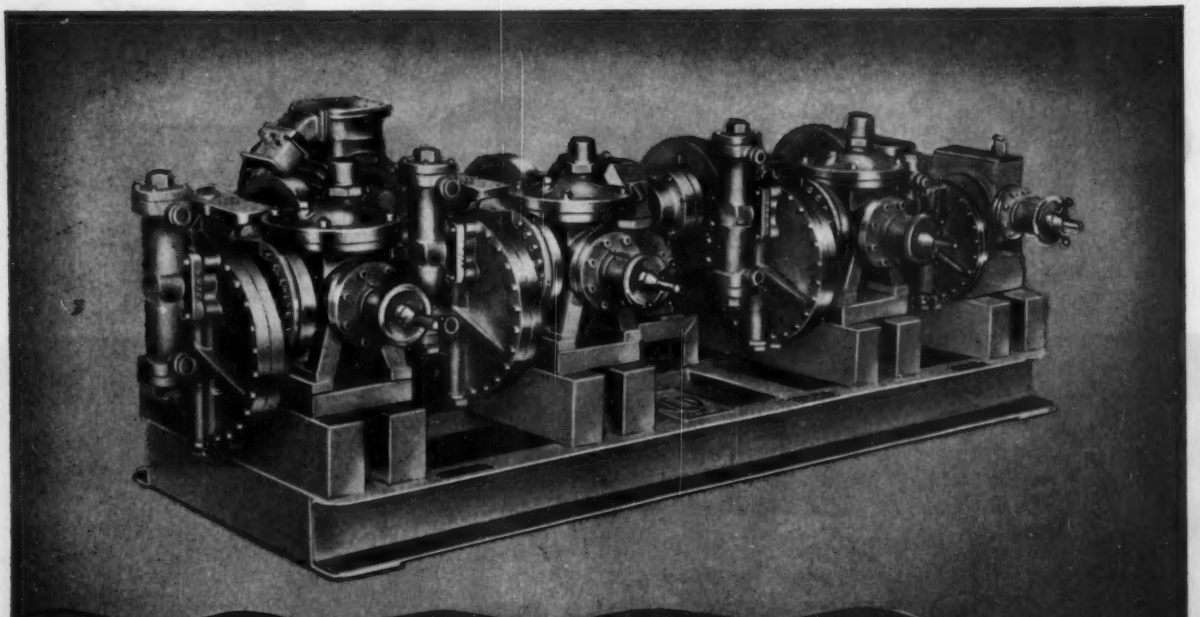




This liquid-liquid heat exchanger design flow sheet shows the route taken by Kellogg's electronic computer to obtain optimum design results. The boxes shown at right indicate the paths taken by the machine in arriving at the solution. Photograph at right is of a partial tabulation, showing how the computer presents results.

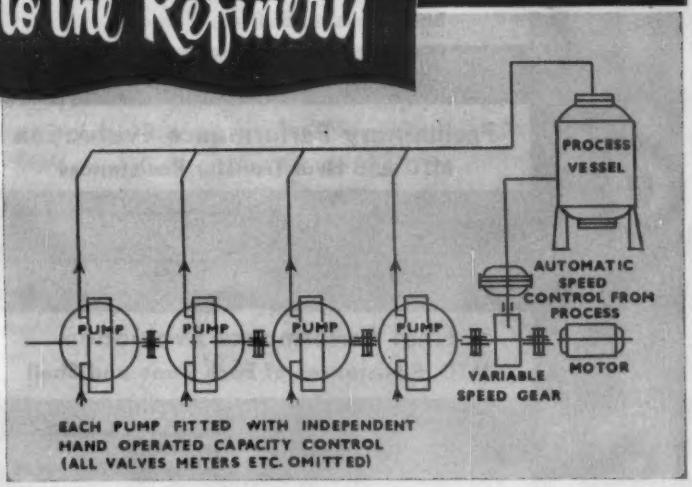
HEAT EXCHANGER		
ITEM NO & TYPE	75614 C	
ARRANGEMENT SERIES PARA	2 0	
SURFACE TOTAL PER SHELL	2179 35960	1089 67630
TOTAL FLUID 1000 LBS HR	148 00000	371 00000
SP GRAVITY LIQUID	87630	87620
TEMP VISCOSITY F CS A	53130 01306	53130 01706
TEMP VISCOSITY F CS B	53300 01102	53300 01205
TEMPERATURE HOT	300 00000	350 00000
TEMPERATURE COLD	130 00000	286 00000
TUBE PASSES PER SHELL	00000	2 00000
PRESS DROP ALLOW PSI	10 00000	15 00000
PRESS DROP CALCD PSI	9 96980	11 26021
FOUL RESIST & TUBE DIAMTR	00004	1 00000
DUTY MM BTU HR & MTD HTD	13 30000	87 64713
TOTAL RESIST SERVICE CALCD	01436	01163
DESIGN PRESSURE PSI	150 00000	300 00000
TUBE NUMBER AND LENGTH FT	212 42078	20 00000
SHELL ING DIAM BAFF PITCH	100	4 81250

For more data on advertised products, use Readers' Service Cards, last page.



Automation comes to the Refinery

The above photograph illustrates an assembly of four hydraulically operated piston diaphragm pumps of various capacities, each fitted with micro capacity control.



The pumps are driven by one motor through a variable speed hydraulic gear box fitted with standard pneumatic diaphragm head connected to the control so that the speed of the complete unit can be varied from zero to full by a signal pressure from 3 to 15lb. per square inch. This in conjuction with the individual capacity control on each pump enables the rate of delivery of any mixture to be automatically controlled from the process plant.

E.C.D. LTD TONBRIDGE · KENT

E.C.D. LIMITED · ENGINEERS

TONBRIDGE · KENT · ENGLAND

Telephone : Tonbridge 2237 (3 lines)

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Refinery Insulation

All CAPOSITE moulded insulation materials are made of Amosite asbestos. The photograph clearly demonstrates the immense volume which is obtained when the natural Amosite is fiberised—the sign of high efficiency as an insulating medium.

CAPOSITE is supremely well suited to the thermal insulation of oil refineries. With a limiting temperature of 1000°F., high thermal efficiency and great structural strength and resilience, CAPOSITE has gained for itself a unique position among thermal insulation materials used by the Oil Industry.

CAPOSITE MOULDED ASBESTOS FIBRE PIPE INSULATION

EFFICIENCY DATA SHEET—PIPE SIZES 6" to 10" BORE.

HOT FACE TEMPERATURE °F.			400°F			600°F			800°F		
THERMAL CONDUCTIVITY K—B.Th.U. in./sq. ft./hr./in./°F.			0.43			0.47			0.53		
MEAN TEMPERATURE °F.			250			350			450		
Nominal Pipe Size	O.D. pipe	Thickness of Insulation	Heat Loss B.Th.U. sq. ft. hr.	Effic. %	Surface Temp. °F.	Heat Loss B.Th.U. sq. ft. hr.	Effic. %	Surface Temp. °F.	Heat Loss B.Th.U. sq. ft. hr.	Effic. %	Surface Temp. °F.
6"	6⅝"	1"	135	87·7	126	233	90·6	167	354	92·5	218
		1½"	102	90·8	107	177	92·9	135	270	94·3	171
		2"	83·6	92·4	97	145	94·1	118	223	95·3	145
		2½"	71·8	93·5	91	125	95·0	107	192	96·0	128
		3"	63·5	94·2	86	110	95·5	100	170	96·4	117
		3½"	57·3	94·8	83	100	96·0	95	154	96·7	109
		4"	52·6	95·2	81	91·7	96·3	91	142	97·0	103
8"	8⅝"	1"	130	88·0	127	225	90·8	169	341	92·7	222
		1½"	97·7	91·0	108	169	93·1	137	258	94·5	174
		2"	79·2	92·7	98	138	94·4	120	211	95·5	148
		2½"	67·4	93·8	92	117	95·2	109	180	96·1	131
		3"	59·2	94·6	87	103	95·8	102	159	96·6	120
		3½"	53·2	95·1	84	92·7	96·2	96	143	96·9	111
		4"	48·5	95·6	82	84·6	96·5	92	131	97·2	105

These figures are compiled from results of official tests by THE NATIONAL PHYSICAL LABORATORY, TEDDINGTON, computed in accordance with formulae shown in BRITISH STANDARD SPECIFICATION appendices.

Please write for full technical details

THE CAPE ASBESTOS COMPANY LIMITED
114 & 116 Park Street, London, W.1.
Cables: Incorrupt, London.

CAPOSITE REGD
Amosite Asbestos Blocks and Pipe Sections

Enquiries in **CANADA** to: **Cape Asbestos (Canada) Ltd., 200 Bloor Street East, Toronto, Ont.**
U.S.A.: The North American Asbestos Corporation, 141 West Jackson Boulevard, Chicago, 4, Illinois.
SOUTH AFRICA: Cape Asbestos South Africa (Pty.) Ltd., P.O. Box 2533, Johannesburg; ITALY: Capamianto S.P.A., via Sant' Antonino 57, Turin.
FRANCE: Isolamiante S.A. 37 Avenue Franklin D. Roosevelt, Paris 8e.

H&G

PROCESS ENGINEERING SERVICES

for the

CHEMICAL, PETROLEUM & FUEL INDUSTRIES

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PROCESS DEVELOPMENT

PROCUREMENT

PROGRESS & INSPECTION

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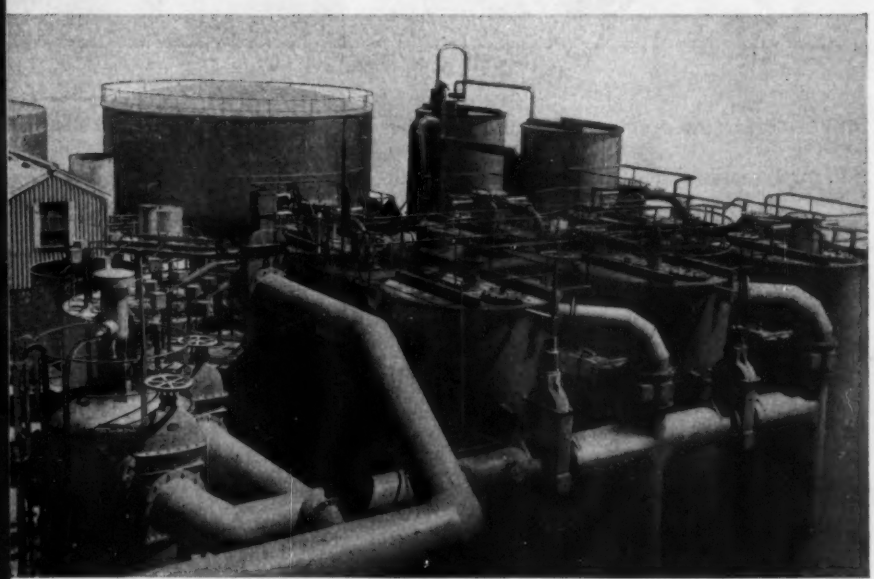
OPERATION



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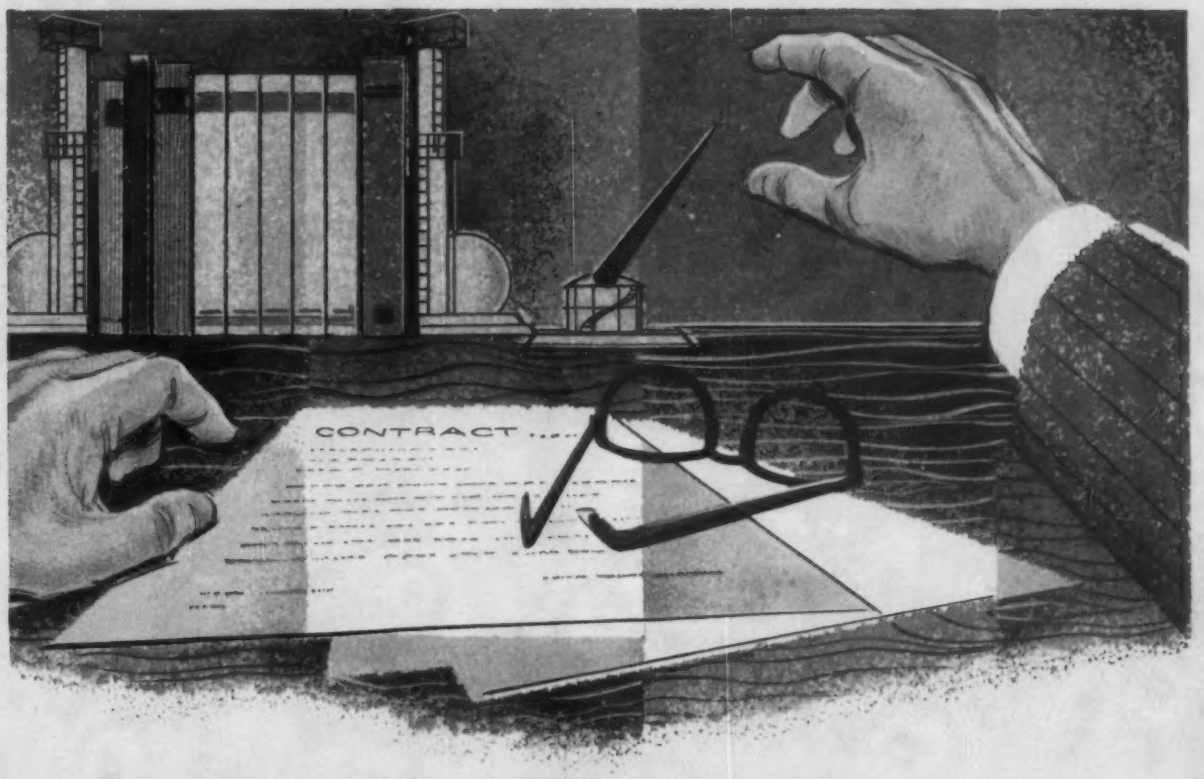
ESTABLISHED 1892



The easiest way in the world for you to ...avoid turnaround trouble!

All too frequently your need for a turnaround isn't revealed until there's an operational failure. Yet it is so easy to avoid the excessive costs and inconvenience of sudden, unplanned shut-downs.

Simply contract with Procon for a schedule of turnaround maintenance. Then your downtime can be economically planned in advance and one of Procon's experienced turnaround crews will overhaul your unit expertly and get it back on stream in the shortest possible time.

Procon men are specialists on turnarounds. We are doing more of them than any other construction firm. Our experience can provide a time-and-money saving answer to your turnaround problems. We will be glad to give you full information about it any time.

PROCON

PROCON *Incorporated*
1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS, U.S.A.

PROCON *(Canada)* LIMITED
TORONTO 18, ONTARIO, CANADA

PROCON *(Great Britain)* LIMITED
LONDON, W. C. 2, ENGLAND.

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

For more data on advertised products, use Readers' Service Cards, last page.

Problem: Lengthen time between turnarounds...

Raise production...

Solution: Ljungstrom® Air Preheater

With a Ljungstrom stills stay on stream at top capacity months longer, because preheated air mixes more thoroughly with fuel. More complete combustion greatly reduces slag forming material. You generate higher flame temperatures, increase heat-transfer rates.

That's why four of your present processing units can do the work of five. With Ljungstrom Air Preheaters each unit's output can increase as much as 25%. Example: One pipe still in an eastern refinery went from 12,000 barrels to 18/20,000 barrels after application of a Ljungstrom.

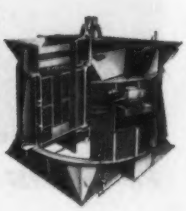
How fast is "WRITE OFF"?

Ljungstrom has many other advantages. You save up to 20% in fuel... furnace design is more economical, with no need for convection surfaces... many fuels you used to throw away can be used... through-put is consistently improved... product quality is higher. You can see, therefore, why a Ljungstrom is paid out in nine months or less.

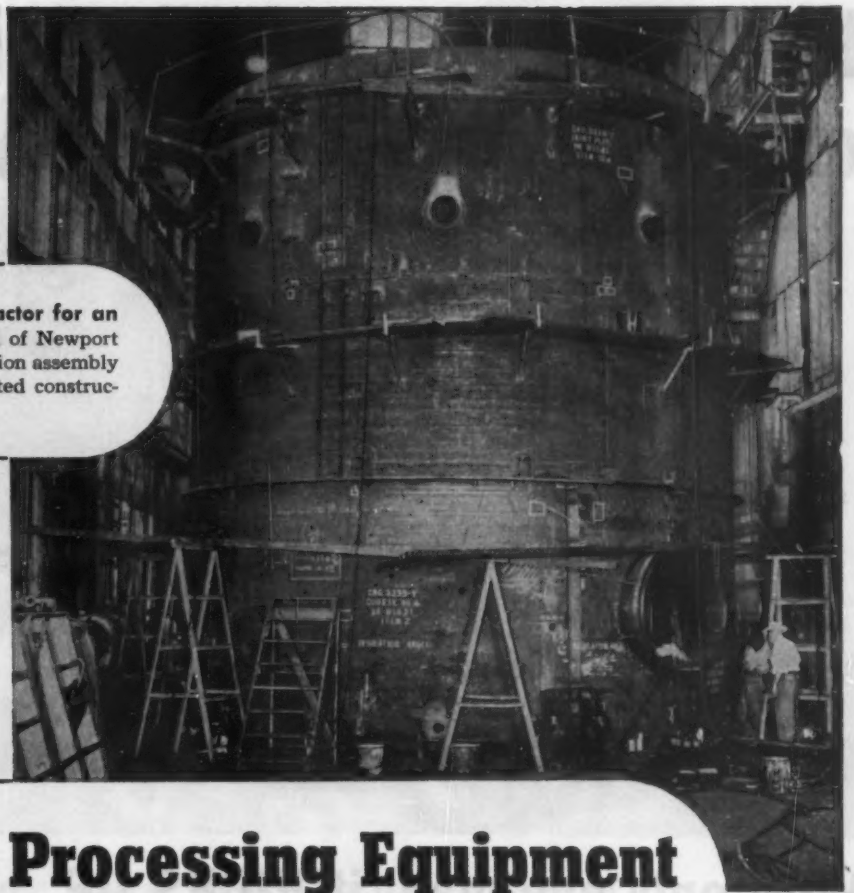
For more complete details on what the Ljungstrom Air Preheater can do for you – for an analysis of the heat recovery benefits attainable in fuel burning equipment – call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.



The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.



Course number four of a reactor for an overseas oil refinery. Typical of Newport News plant methods, the precision assembly of this unit in the shop expedited construction of the reactor in the field.

Petroleum Processing Equipment

...Built by Specialists in Metal Fabrication

Careful attention to detail characterizes the work of Newport News craftsmen...

They've fabricated millions of tons of steel including corrosion-resistant alloy, clad and other special steels for many diverse industries.

Newport News handles the job exactly as you want it done, for maximum results per dollar invested.

Specialized production techniques, advanced plant methods and a complete range of facilities along with many special purpose machines contribute to the excellence of Newport News fabrication.

Let us bid on equipment for your present or future projects. Learn how Newport News can help you...send for our booklet entitled "Facilities and Products." It's yours for the asking.

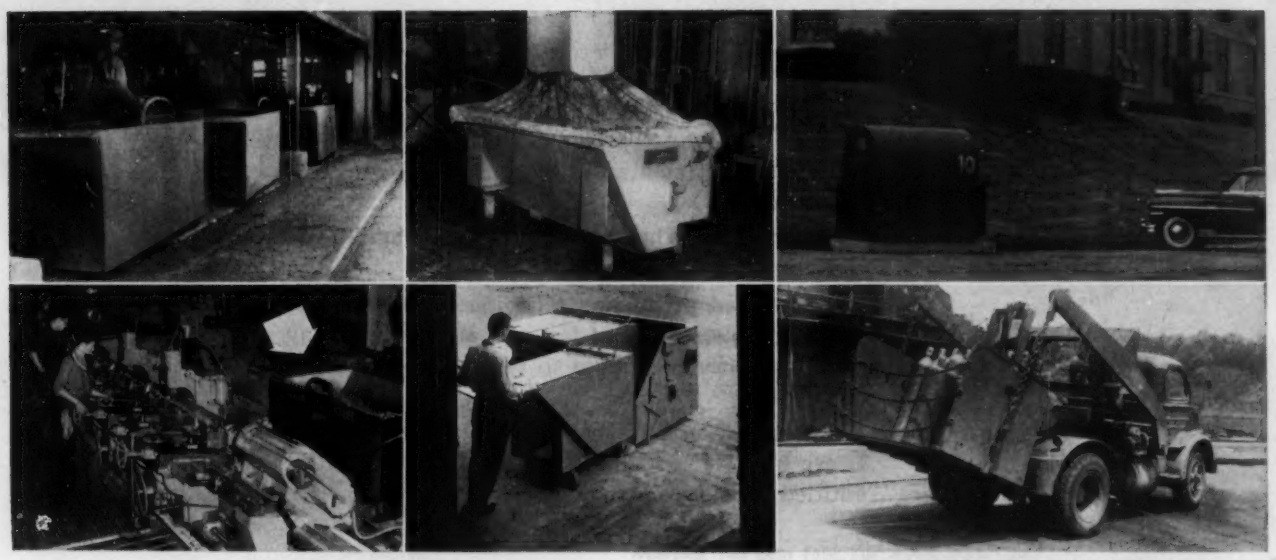
Newport News Shipbuilding and Dry Dock Company

Newport News, Virginia

For more data on advertised products, use Readers' Service Cards, last page.

Here's the most versatile....lowest cost of bulk materials handling by truck ever

With only one man, it PICKS UP . . . HAULS . . . Serves scores of big steel containers, all sizes and



It's the DEMPSTER DUMPSTER® System

ABOVE ARE BUT A FEW of the hundreds of different Dempster-Dumpster Detachable Containers at work in industry today—containers built in capacities up to 21 cu. yds. . . . several times the capacity of the average dump truck body. It's like having one truck with scores of bodies!

For more data on advertised products, use Readers' Service Cards, last page.

method devised!

Here's MASS-HANDLING of bulk materials with one truck . . . one man! Multiply this simple pick up, haul and dump operation by scores of steel containers built to meet your requirements for handling waste or salvable materials, raw and finished products, fluids, including acids, combustibles, dusty materials, etc. No other method handles waste and bulky materials so cheaply!

and DUMPS (or sets load down intact) designs — handling materials of every description

WITH NO OBLIGATION on your part, our engineers will be glad to make a comprehensive fact-finding survey to determine the cost-cutting possibilities of this equipment in your plant. Ask us for complete information. Manufactured exclusively by Dempster Brothers, Inc.

5205

DEMPSTER BROTHERS
527 Dempster Building
Knoxville 17, Tennessee

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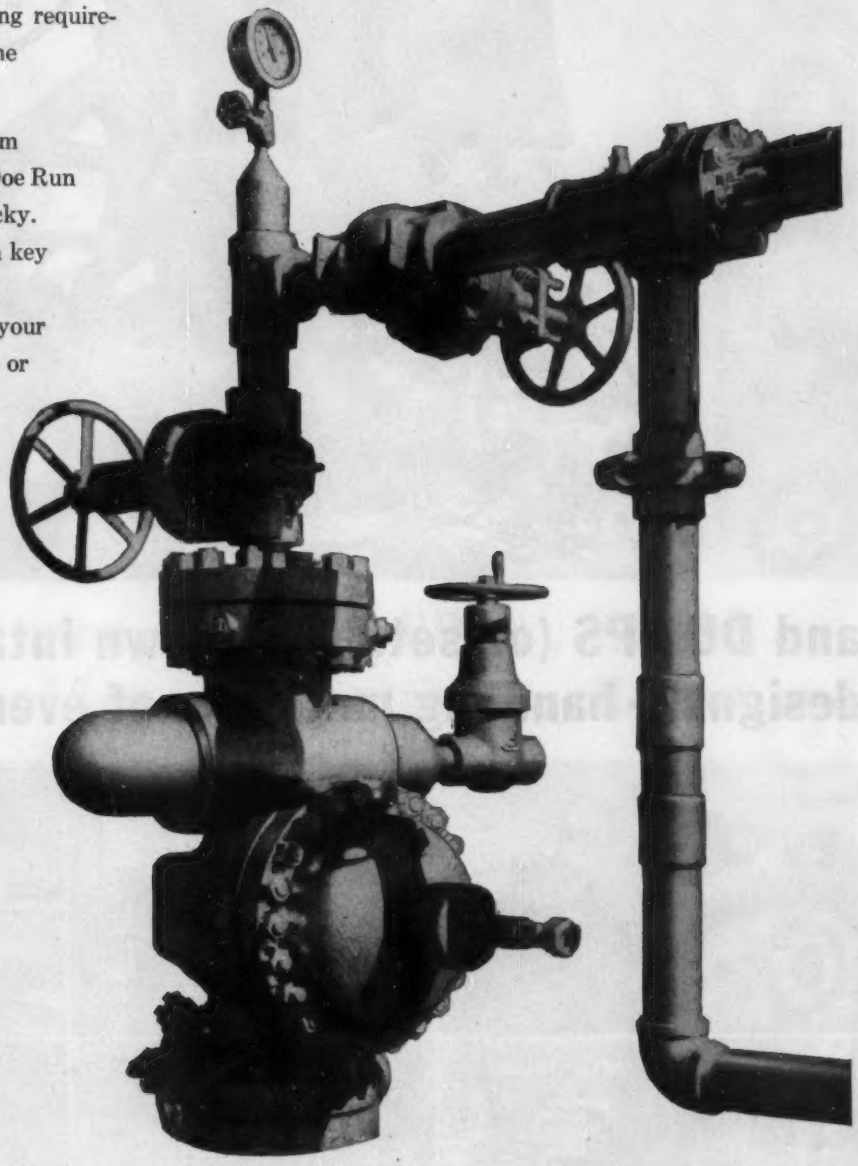
ETHANOLAMINES
are there

. . . in the quantity and quality specified and shipped to meet your operating requirements for gas scrubbing and the absorption of acidic gases.

Tank car, tank truck, and drum shipments are made from the Doe Run Plant at Brandenburg, Kentucky. Local stocks are maintained in key industrial areas. For technical information and samples, call your Olin Mathieson representative or write today.



for better gas scrubbing

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OLIN MATHIESON CHEMICAL CORPORATION
INDUSTRIAL CHEMICALS DIVISION • BALTIMORE 3, MD.

4546

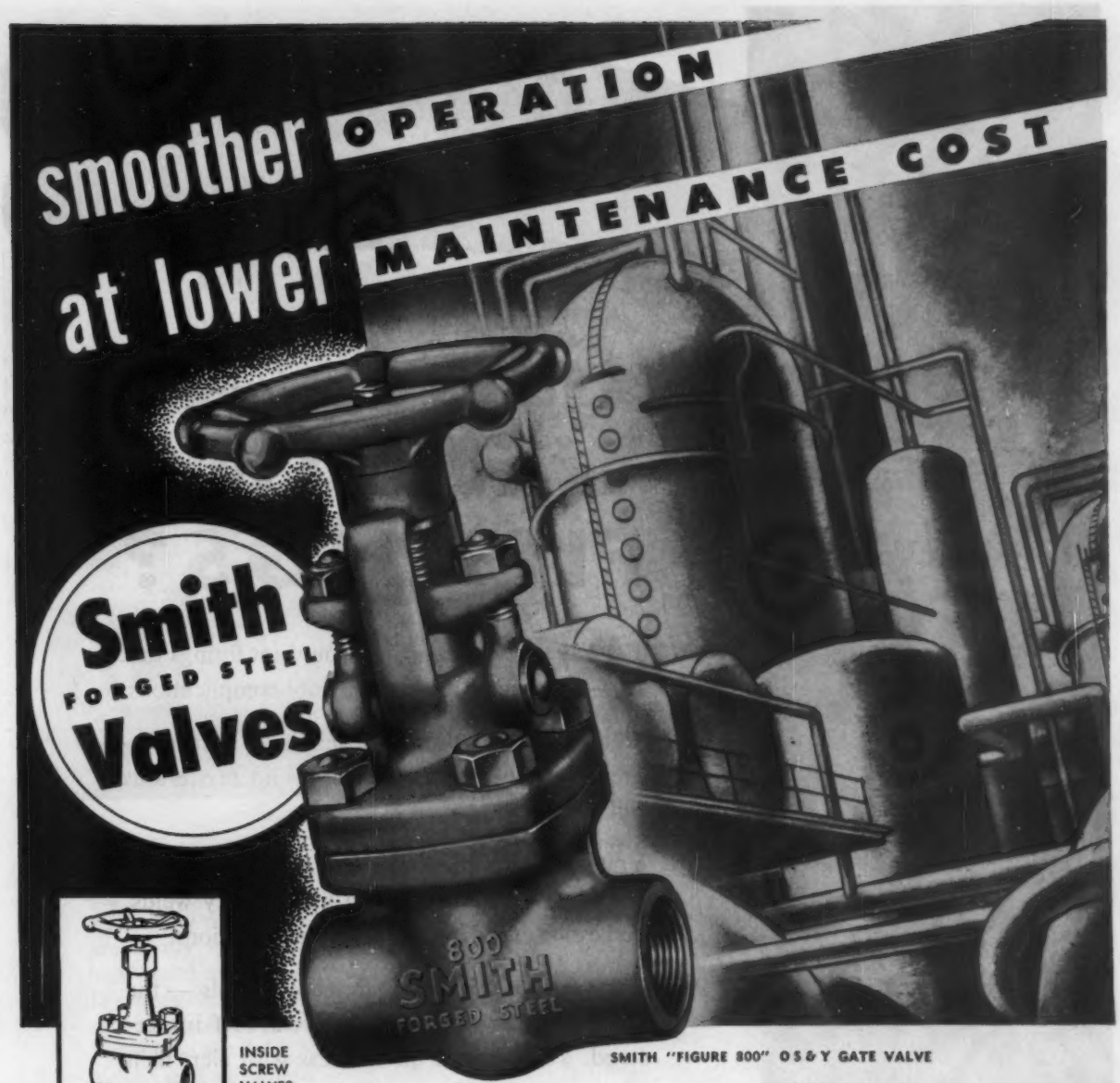
MATHIESON

INORGANICS: Ammonia • Bicarbonate of Soda • Carbon Dioxide • Caustic Potash • Caustic Soda • Chlorine • Hydrazine and Derivatives • Hypochlorite Products • Muriatic Acid • Nitrate of Soda • Nitric Acid • Soda Ash • Sodium Chlorite Products • Sulphate of Alumina • Sulphur (Processed) • Sulphuric Acid

ORGANICS: Ethylene Oxide • Ethylene Glycols • Polyethylene Glycols • Glycol Ether Solvents • Ethylene Dichloride • Dichloroethylether • Formaldehyde • Methanol Sodium Methylate • Hexamine • Ethylene Diamine • Polyamines • Ethanolamines • Trichlorophenol • Surfactants

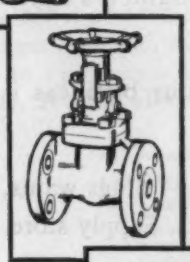
smoother OPERATION at lower MAINTENANCE COST

Smith FORGED STEEL **Valves**



SMITH "FIGURE 800" O S & Y GATE VALVE

INSIDE SCREW VALVES



FLANGED END GATE VALVES

NEEDLE GLOBE VALVES

A combination of features, especially designed and precision-built to meet the exacting needs of the Refinery and Petrochemical industries, make SMITH VALVES your surest approach to smoother operation at lowest possible maintenance cost.

- STEMS — heat treated to "375 Brinnel" for extra toughness with 30% stronger *rolled threads* which eliminate chatter or cutter marks.
- GATES — "tear drop" design with accurately broached gate guides minimizes scuffing and insures perfectly controlled operation at high temperatures and pressures.
- SEATS — diamond-hard chrome faced seats in combination with "500 Brinnel" gates prevent seizing, galling and abrasive wear.
- Bolted bonnet design and flexitallic gaskets insure lower cost installation, easier maintenance and repair.

Write today for literature giving complete details and prices.

NEW ENGLAND VALVE *Corporation*

P. O. BOX 1047 • WORCESTER, MASSACHUSETTS

West Coast Distributors: BETHLEHEM SUPPLY CO., LOS ANGELES, CALIFORNIA

What do you want in WELDING FITTINGS?

For any welded piping job you want fittings that fit — no disgusting last-minute complications.

You want fittings made of materials that measure up to your specifications — no mysterious failures.

You want a source for special as well as regular fittings. You want to avoid unnecessary welds, makeshift expedients, clumsy combinations.

You want to avoid procurement ordeals — the business of trying to make yourself understood. You want to do business with alert men who speak your language — engineers if you need them.

And — you want to know your business is appreciated.

The best answer to your welding-fittings wants, of course, is in your nearby J&L Supply store.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

SERVING THE UNITED STATES AND CANADA

27-G

Closer Control of Flow and Liquid Level

. . . with Honeywell's Differential Converter

USE THIS mercuryless remote transmitter for practically *any* application requiring precise, high-speed measurement of flow or liquid level. It's accurate within 1%. Equally fast in response up the scale or down. Range is continually adjustable in the field. Mount this compact, lightweight unit anywhere.

The *Differential Converter* operates on the force-balance principle, transmitting by a single air line to a pneumatic receiver as far as 1,000 feet away. It's the ideal companion for Honeywell *Tel-O-Set* miniature recorders, indicators and controllers.

For details on how *Differential Converters* make possible tighter control in your most critical applications, call your nearby Honeywell sales engineer today. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

For measuring liquid level in closed tanks: One model with a normal range of 0-14 to 0-200 inches of water, and two suppression ranges of 0-75 and 50-200 inches. Suppression spring permits direct, instead of reverse, reading of instrument.

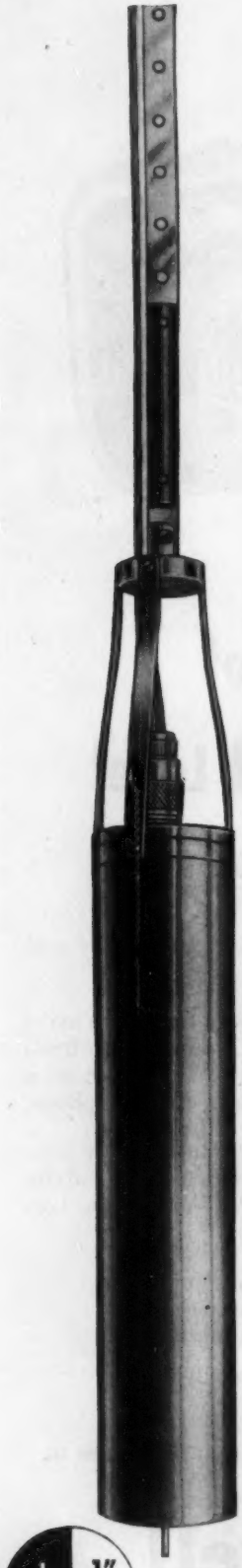
For measuring flow and liquid level in open tanks: Two models with ranges from 0-20 to 0-200 inches of water differential and 0-100 to 0-1000 inches.

● **REFERENCE DATA:** Write for Bulletin 2290-1, "*Differential Converter* Liquid Level Transmitter"; Catalog 2321 "Flow Meters"; and Specification 248, "*Differential Converter* Flow Transmitter".

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

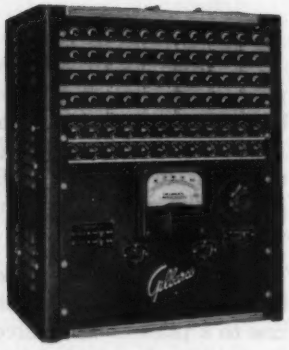


Now offers Gilbarco a complete Electronic tank gauging system

100% MORE ACCURATE

This new Gilbarco Electronic Tank Gauge is a completely electronic device, NOT a float. It provides unmatched accuracy of measurement ± 1/16" at the tank base or remotely if desired.

100% AUTOMATIC



The Gilbarco Remote Receiver operates in conjunction with the Electronic Tank Gauge. It provides accurate readings of level and temperature on all tanks *from the instrument house.*

Here is complete AUTOMATION for your tank gauging. Five, ten, or fifty tanks — the New Gilbarco Electronic Tank Gauging System will handle the job accurately and automatically.

Gilbarco Tank Gauge is completely electronic . . . gauges tank levels to ± 1/16 of an inch . . . provides unmatched accuracy for all liquid measurement in all types of low pressure tanks.

Gilbarco Gauges can be installed without taking tanks out of service. They are not affected by variations in specific gravity or viscosity. And they are provided with built-in checks for assurance of maintained accuracy.

Here is complete automation — for all tank gauging.

Save time and money on your tank gauging. Get all the facts on the new Gilbarco Tank Gauging System.

Write today for Complete Details

GILBERT & BARKER MANUFACTURING COMPANY, WEST SPRINGFIELD, MASS. • TORONTO, CANADA

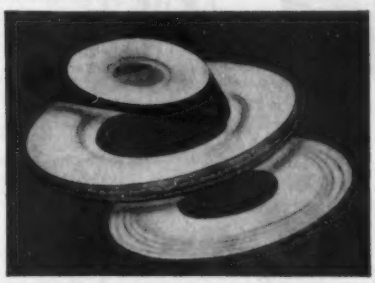
DU PONT

PETROLEUM ENGINEERING NEWS

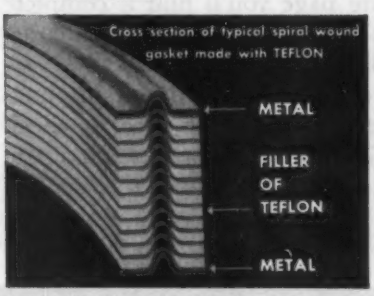
LATEST PROPERTY AND APPLICATION DATA ON TEFLON® tetrafluoroethylene resin

Gaskets and packings of TEFLON® resist corrosives and high temperatures...reduce downtime

PACKINGS of TEFLON provide uniform packing performance and long service life. Solid packings are impervious to liquids and gases. Low frictional coefficient of TEFLON reduces torque . . . increases mechanical efficiency. Impregnated asbestos packings and plastic packings are also available.



ENVELOPE GASKETS of TEFLON consist of a soft filler covered by a jacket of TEFLON. They are used for sealing large diameters and where bolting pressures must be limited, as in glass-lined equipment and pipe made from ceramics.



SPIRAL-WOUND gaskets and gaskets made from asbestos and glass cloth impregnated with TEFLON are used in high-pressure installations such as pipe joints, reaction kettles, steam couplings, pump bodies, pressure tanks.

Du Pont TEFLON is unaffected by petroleum distillation products, catalysts and reagents. For example, TEFLON is the only packing material used successfully in a 3,600-rpm pump handling highly corrosive butyl extract. This mixture of sulfuric acid and petroleum fractions is typical of the corrosive refinery fluids so easily handled by TEFLON.

All types of gaskets and packings are available in TEFLON. Most of the *mechanical* properties of solid TEFLON are comparable to those of the best grades of rubber-bonded compressed asbestos. Gasket design for the two materials is therefore similar. TEFLON has a naturally slippery surface. For this reason, less torque is needed to turn shafts or stems equipped with packings made of TEFLON, even under high gland pressures. TEFLON compounded with additives such as asbestos, bronze, calcium fluoride, glass fiber and graphite can be used where special mechanical properties are required.

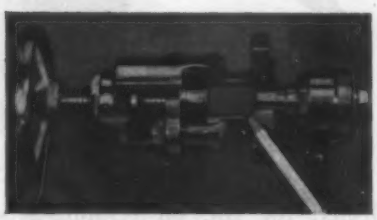
TEFLON tetrafluoroethylene resin is inert to nearly all chemicals and solvents in commercial use. The few exceptions to this include attack by the alkali metals under certain conditions. At high temperatures and pressures, halogens and certain halogenated chemicals and solvents may also affect TEFLON. The mechanical strength of TEFLON is high over a wide range of temperatures. This durable material is rated for use up to 500° F. and displays excellent properties at very low temperatures. Seals, bearings, packings and other components of TEFLON operate reliably year after year. Maintenance and replacement costs go down. Productive capacity is increased.

Wherever you have the problem of handling corrosive liquids or gases, especially at high temperatures, Du Pont TEFLON may well be the material you need for cost-saving operation. Find out what TEFLON can do for you by mailing the coupon below.

TEFLON®

is a registered trademark . . .

TEFLON is the registered trademark for Du Pont tetrafluoroethylene resin, and should not be used as an adjective to describe any other product or any component part; nor may this registered trademark be used in whole, or in part, as a trade name for any other product.



USED IN VALVE PACKING of petrochemical equipment, TEFLON offers outstanding resistance to heat and corrosives. Valves with packings of Du Pont TEFLON successfully handle nitric acid at 365° F. and dry chlorine gas at 100 lb./sq. in.

SEND FOR INFORMATION

Mail this coupon for additional property and application data on Du Pont TEFLON tetrafluoroethylene resin.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept.
Room 362, Du Pont Building, Wilmington 98, Delaware

Please send me more information on Du Pont TEFLON tetrafluoroethylene resin. I am interested in evaluating this material for_____

Name_____

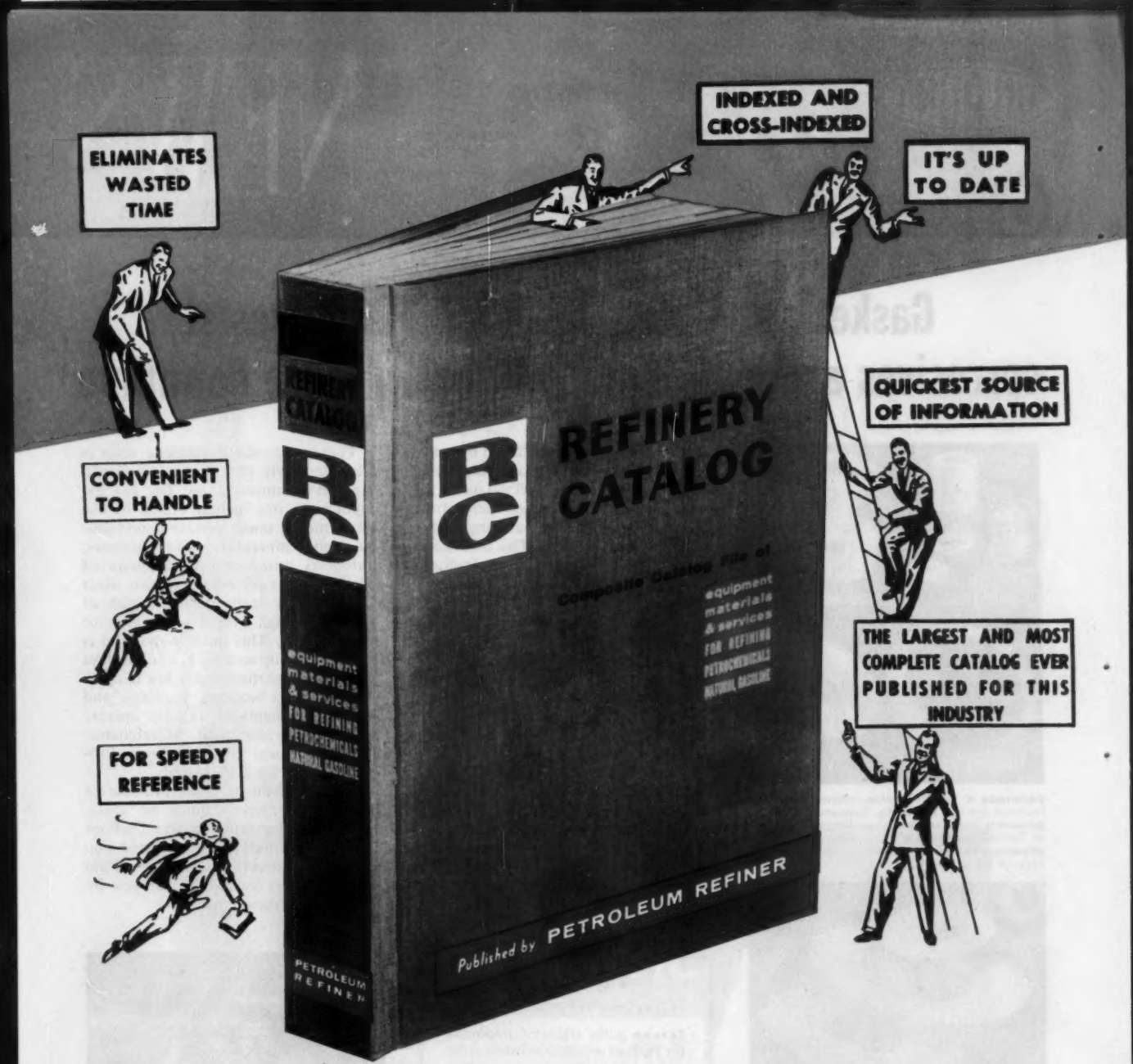
Company_____ Position_____

Street_____

City_____ State_____

Type of Business_____

IN CANADA: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec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REFINERY CATALOG
Composite Catalog File of
equipment materials & services FOR REFINING PETROCHEMICALS NATURAL GASOLINE
Published by PETROLEUM REFINER

The largest, most complete catalog ever published for the oil refining-processing industry, the new 1957 REFINERY CATALOG is serving as a genuine time-saver for operating executives, superintendents, foremen, engineers, purchasing agents and others who buy or specify equipment and supplies.

More than 300 leading manufacturers and suppliers have filed their complete or condensed catalog data in this edition. Compiled by the manufacturers themselves, this information is arranged and indexed to offer a quick and convenient means of locating items of equipment and services, and sources of supply of products in which you may be interested.

On the opposite page you'll find a complete list of companies whose complete or condensed catalogs appear in the current REFINERY CATALOG. When you're looking for data on products handled by these companies, be sure to check your REFINERY CATALOG. It is the most complete source of buying information available in one volume today.

JUST OUT!

THE NEW 1957

For your convenience... these leading manufacturers and suppliers have filed complete or condensed catalog data in the 1957 Refinery Catalog.

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Aluminum Company of America, Process Division
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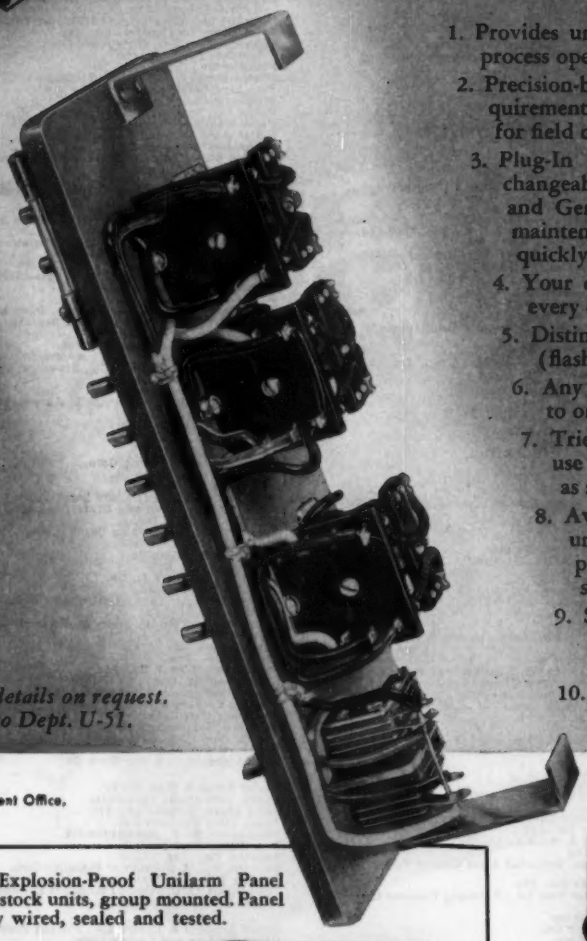
REFINERY CATALOG

No Other Alarm System Has ALL The Advantages Of

R&S UNILARM*...



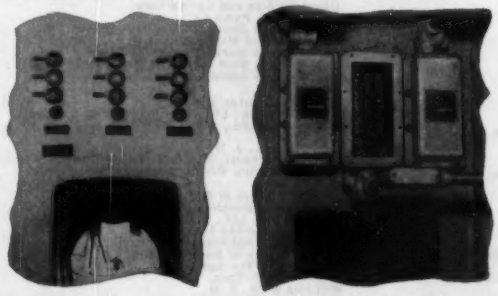
1. Provides unfailing supervision of equipment and process operations.
2. Precision-built to Underwriters' Laboratories requirements. Completely wired and tested . . . ready for field connections.
3. Plug-In Panel (large illustration), fits interchangeably into Explosion-Proof, Vaportight and General Purpose enclosed units. Reduces maintenance to a minimum . . . easily and quickly replaced with a spare unit.
4. Your choice of 100 standard circuits to suit every conceivable application.
5. Distinctive visual signal for each condition (flashing light) insures immediate attention.
6. Any number of Unilarms may be connected to one audible signal.
7. Tried and tested in the field. Thousands in use giving trouble-free protection. Accepted as standard by leading industries.
8. Available as individual unit or in multi-unit Panels. Also time delay types for applications subject to high surge or excessive vibration.
9. Saves space, engineering costs, installation and maintenance over other alarm systems.
10. Acknowledgement-test switch permits periodic testing of each Unilarm circuit.

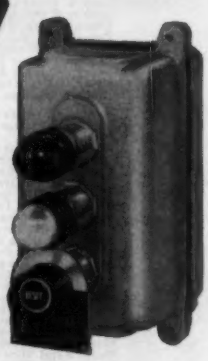
Complete details on request. Write to Dept. U-51.

*Reg. U.S. Patent Office.

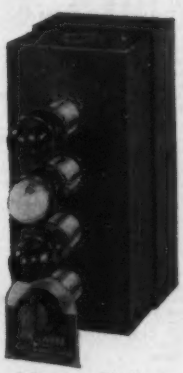
D1

Special Explosion-Proof Unilarm Panel showing stock units, group mounted. Panel is factory wired, sealed and tested.





Vaportight Unilarm



General Purpose Unilarm

R&S Unilarm is also available in a complete line of Surface Mounted Types — Explosion-Proof, Vaportight and General Purpose.

RUSSELL & STOLL COMPANY, INC. • 125 BARCLAY STREET, NEW YORK 7, N.Y.

RUSSELL & STOLL

PRECISION-BUILT ELECTRICAL EQUIPMENT—SINCE 1902

S/Kapades in industry

THE CASE OF THE PERIODIC PUMPING PROBLEM AND THE PATIENT PLANT ENGINEER

". . . ub glub bedubtub
(this situation's becoming impossible)," glubbled Barney, the patient plant engineer.

"Ub tub ud ub tub ud ub tub
(I've tried and I've tried and I've tried)," bubbled Shorty, his faithful, conscientious assistant,
"Bud dub pubs wud hubtub dub slubb
(But the pumps won't handle the sludge)—it ruins them every time."

"Wub, subtub's *gub* tub bub dub
(Well, something's *got* to be done)," answered Barney. "Or, *I'll* lose my *patience* AND YOU'LL LOSE . . . well, you'll be an *ex-faithful, ex-conscientious* assistant plant engineer."

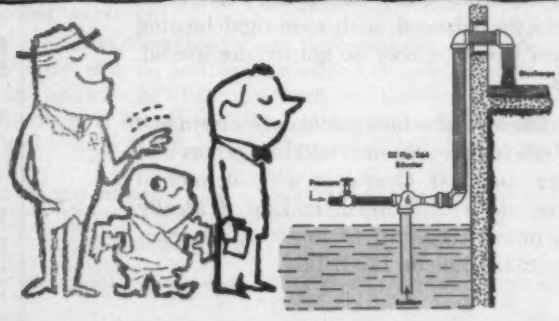
With that, Shorty stubbled away . . . in the direction of his office and catalog files.

"I've got it," shouted Barney. "It says either an SK Jet Eductor or Syphon is good for pumping liquids where solids or semi-solids must pass through the apparatus and is ideal for use where pumping is periodic."

So he called in his nearest SK Sales Engineer who made an on-the-spot survey of the situation and, because of certain special considerations, recommended the use of an SK Fig. 264 Water Jet Eductor.

PATIENCE REWARDED

It paid to be patient. Now, the recurring drainage problem has been solved, simply and inexpensively. The SK Fig. 264 Water Jet Eductor uses pressure liquid, entering the eductor through a nozzle, to create a vacuum in the line which causes the suction liquid to flow up into the body of the eductor where it is entrained and discharged. Solids and semi-solids present no problem. Since there are no moving parts and the eductor is self-priming, the jet is ready to operate when required.



MORAL:

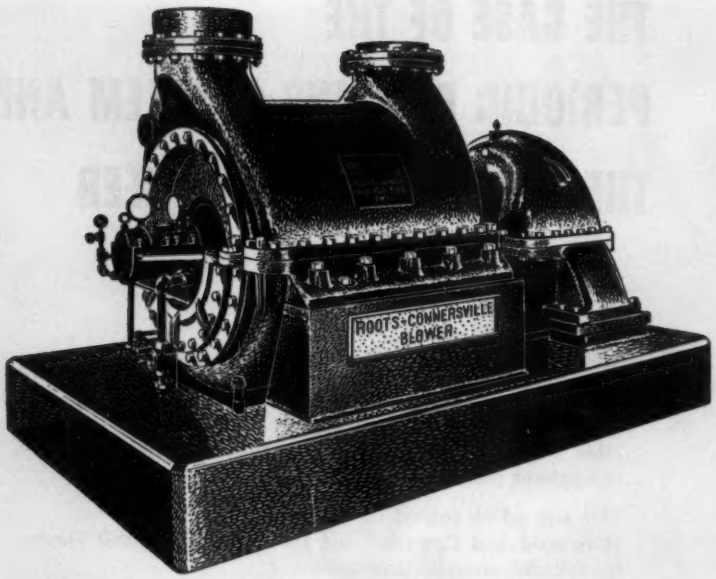
Get acquainted with all types of SK Jet Apparatus. Send for a copy of Condensed Bulletin J-1. Make use of a qualified specialist, your nearest SK Sales Engineer.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS

2257 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin 10-RA.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin 17-A.

For more data on advertised products, use Readers' Service Cards, last page.



R-C centrifugal blowers assure accurate control of volume and pressure

At any speed, Roots-Connersville centrifugal blowers assure uniform delivery of air or gas without the use of receivers. In matching supply to changing demand, this inherent operating advantage simplifies accurate and instantaneous control of volume and pressure.

R-C centrifugals may be direct-connected to high speed electric motors or turbines. Operating speeds may be further raised with speed increasing gears. Occupying a minimum of space and perfectly balanced, with semi-rigid bearing supports to dampen vibration, they do not require special, costly foundations.

Liberal design of diffuser and return passages results in low velocities, normal efficiency even when build-up occurs and exceptionally quiet operation. Operating without internal lubrication, oil-free air is discharged, making it ideally suited for exacting process applications. For complete specification details, write for Bulletin 120-B-14.

Engineers—unusual career opportunities await you at Roots-Connersville. Address your resume to Professional Employment Manager.

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.

257 Crescent Ave., Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto, Ont.

The Mail Box . . .

Column Balance

To The Editor:

The article "Is Your Distillation Column In Balance" in the November 1956 issue has been read with considerable interest.

For a number of years I have been interested in getting some college group to do research on the effect of column balance or column upset, whichever way one looks at it.

We now have available, and have had for a number of years the instruments to control a fractionation column very precisely. Through economics and mis-application we sometimes do not achieve this final result.

If the flow of all streams in and out of a tower can be controlled, then the tower must be in balance. One of our rules for pressure control is, "One does not control pressure unless one controls flow. Likewise it may be said that when one controls level, one controls flow, this is true. Also for any other property of the tower which is being controlled."

The ideal situation for ultimate control would be a flow controller on each stream with temperature, pressure and level override. This is an arrangement which is expensive and must be justified in terms of increased efficiency.

Precise control would allow us to make the same separation with fewer bubble trays than otherwise, and also lower heat input and less reflux.

Win Rochelle

Foxboro Company
Odessa, Texas

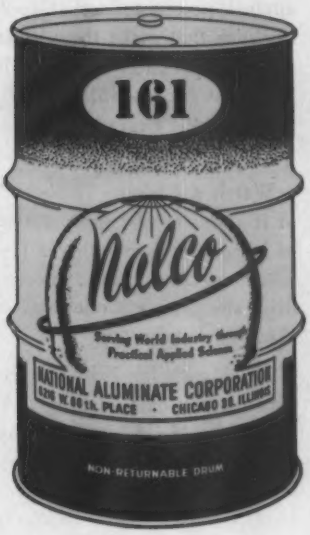
Author Replies

Mr. Rochelle's view is the conventional one that the solution to the problem of the column balance lies in more elaborate and careful "constant conditions." The writer can only repeat from the paper under discussion, "Any argument as to what we should do or might do can be answered by the fact that we do not." Even if perfect instruments and control were available the column balance would still vary with any small changes in the feed composition. And if this feed could be held exactly constant, then the balance

For more data on advertised products, use Readers' Service Cards, last page.

Streamlining

CORROSION CONTROL SERVICES



. . . for oil production and refining

Nalco and Visco corrosion control chemicals and service have set a standard for the oil production and refining industries. The program we are starting in 1957 offers still greater benefits to our oil industry customers.

Beginning now!

VISCO will specialize in producing well corrosion control chemicals. NALCO will specialize in refinery corrosion control chemicals, and water flood and disposal treatment.

This emphasis on specialized service means that each Nalco or Visco Field Service Man has additional proven products to offer his customers. It means that his accounts will get full advantage of the research and development work, and the experience, of both companies. It means a more unified, concentrated approach to sales and service that will benefit the valued customers of both Nalco and Visco.

VISCO PRODUCTS COMPANY
A Unit of National Aluminate Corporation
2600 Nottingham at Kirby
Houston 5, Texas

NATIONAL ALUMINATE CORPORATION
6216 West 66th Place
Chicago 38, Illinois

BRANCHES AND AFFILIATES IN CANADA, SPAIN, ITALY AND WEST GERMANY

Visco® . . . FOR PRODUCING WELL CORROSION CONTROL

Nalco® . . . FOR REFINERY CORROSION CONTROL

For more data on advertised products, use Readers' Service Cards, last page.

COOLING TOWER POWER
is most efficiently utilized by
Marley
Multi-Blade Aerfoil Fans

Marley fans are unexcelled for the job of converting applied power to actual cooling performance, but the qualities that make them positively distinctive are ultra-smooth operation and long-life durability. It requires just two words—MULTI-BLADE and AERFOIL—to point out the characteristics that produce these stand-out advantages.

Watch a 22-foot, 12-blade Marley fan operate; listen to it operate. The customary "huff and puff" pulsation of large fans is not there. There is no structure-shaking vibration. The result? Longer life for speed reducer, drive shaft, fan cylinder and structure. That is the multi-blade advantage.

The Marley fan is inherently rugged and durable. Each blade is a single casting, a rigid, homogenous unit of specially selected aluminum alloy that retains its aerfoil shape permanently. Marley fans never develop tip-sag or service flutter. The design completely eliminates weld and rivet failures, skin cracks, imperfect laminations and internal corrosion.

All machine operations on Marley blades and hubs are carefully quality controlled. Blade surfaces are protected by a double-coated baked plastic finish. Each fan is balanced at the factory and match-marked for field assembly.

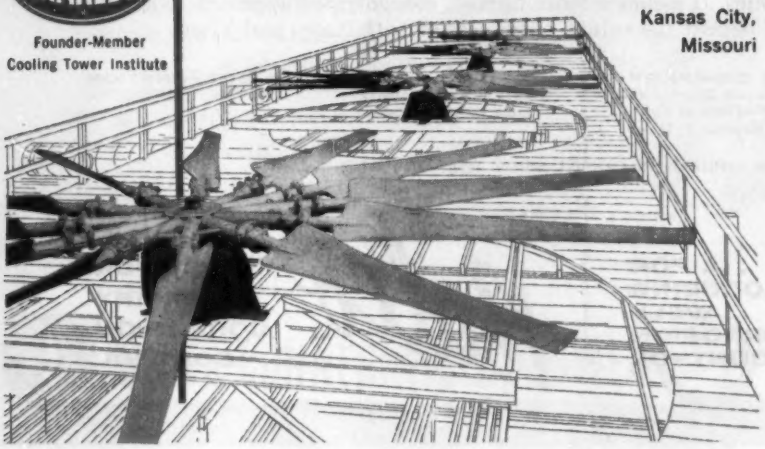
Owners of towers of all types and makes are modernizing their equipment by changing to Marley Multi-Blade Aerfoil Fans—often after side-by-side comparative test with present equipment. Write for Bulletin FH356 and get the complete story of modern design applied to cooling tower fans.

MARLEY

Founder-Member
Cooling Tower Institute

The Marley Company

Kansas City,
Missouri



The Mail Box . . .

would change with the small variations in the atmospheric conditions. The tower insulation would not be perfect. Other sources of balance trouble could be given.

It remains the writer's firm conviction that we are wasting our time aiming at a point, that the basic need here is to provide a control range, an area, so that operation at any point in this area continues to give sharp separations for the end products. No exotic instruments or elaborate hook-ups are needed, only simple instruments doing a single thing. The difficulty here is ourselves, we have not thought this problem through.

W. D. Harbert
United Refining Company,
Warren, Pa.

Help on Costs

To The Editor:

I enjoyed the article in the October issue on "How to Specify Cooling Towers." I thought it very well written and think Mr. Smith should be commended.

I would like very much to see an article written by Mr. Smith, or anyone else familiar with cooling towers, on the subject of cost estimation. I realize, as was stated at the heading of the article, that this is a complex item. And I have not been able to find any good information along this line.

Any help along this line would surely be appreciated.

Dee A. Brannan
Pritchard & Abbott
Fort Worth, Texas

OK's Polyethylene Job

To The Editor:

I have these comments about your Petrochemicals Issue (December, PR).

I feel you have done an excellent job in compiling in one place a wealth of information on new developments reported during the past year. I was particularly pleased to see the report comparing the three polyethylene processes. Of course many pages have been published throughout the year on polyethylene, but you deserve a lot of credit for wrapping this up in one easily understood article.

Gordon C. Inskeep
Assistant to the President
Processes Research, Inc.,
New York

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SIMPLE ARITHMETIC
KOCH FLEXITRAY HAS
12 TO 20% HIGHER CAPACITY
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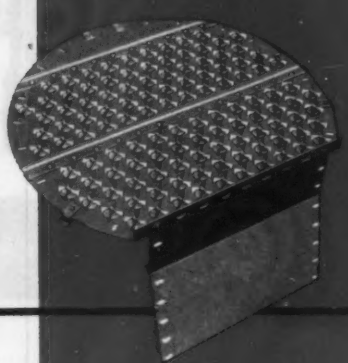

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Better Fuels for the Tanks of Today's Cars!

Year after year, continually higher horsepower and compression ratio in automotive engines have demanded progressively improved motor fuels.

For more than 40 years UOP-developed processes have been contributing to the petroleum refining industry's consistent ability to keep pace with the growing quality requirements. These processes, always made available to refiners everywhere, include:

CONTINUOUS THERMAL CRACKING, the first major improvement in refining methods, developed by UOP nearly 40 years ago.

POLYMERIZATION, a catalytic process developed by UOP and used to convert refinery waste gases into premium quality gasoline.

FLUID CATALYTIC CRACKING, developed to produce greater yields of liquid products and higher octane number gasoline.

PLATFORMING, with which UOP pioneered the use of platinum in a reforming catalyst and originated the commercial designs of catalytic reforming units.

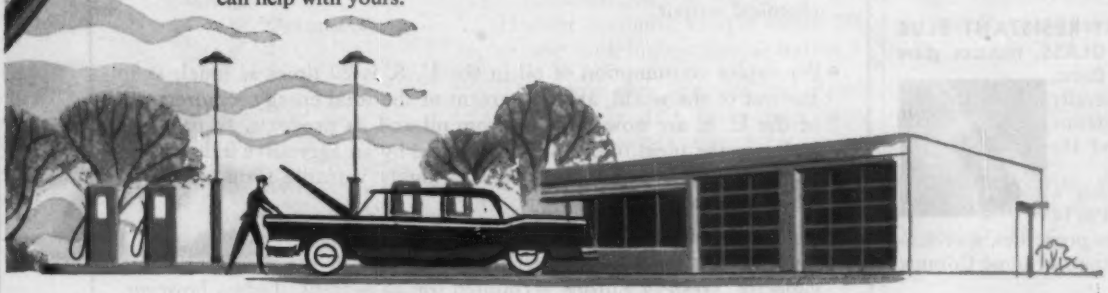
REXFORMING, a combination of UOP Platforming with solvent extraction which permits a refiner to produce even higher octane gasolines.

PENEX, a process which converts the low octane straight chain pentane and hexane fractions into the much higher isocompounds.

"HF" ALKYLATION, a process developed by UOP for producing alkylate, a high octane gasoline blending component, using hydrofluoric acid as the catalyst.

UNIFINING, the process which employs by-product hydrogen from UOP Platforming units to remove sulfur, nitrogen, oxygen and metallic impurities from petroleum distillates by catalytic hydrogenation.

These and other UOP processes, individually or collectively, can provide the answer to most refining problems. We will be glad to tell you how they can help with yours.



UOP

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To see what's going on inside

When you want to look into a furnace, watch acid eat its way into metal, observe a white hot melt in cool comfort, there's only one answer . . . GLASS.

PYREX brand PLATE GLASS No. 7740 is particularly suited for odd-sized sight glasses, fume duct windows, and chemical-resistant surfacing. You can use it for temperatures up to 900° F. It is resistant to thermal shock and indifferent to chemical attack.

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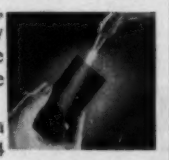
CORNING HEAT-RESISTANT BLUE OBSERVATION GLASS, reduces glare when observing flame, smoke and ash intensity in power plants, marine boiler stations and the like.



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If Oil Could Speak

If oil could speak it would have many fascinating truths to tell the non-oil public—truths that would win thousands of new friends for the oil industry.

But, oil can't speak—you can. You, as an individual, can win many new friends for the oil industry if you will pass the true facts on to your non-oil industry friends.

Here are some of those true facts. They are being presented for one purpose: To keep you posted on your industry, so you can tell the story oil is unable to relate.

Read these facts. You will find them informative—and interesting.

"If Oil Could Speak" it would tell the American public:

- The most important contribution of oil comes in the form of energy which multiplies our capacity to work. The heat engine, working in industry and agriculture, enables us to produce more goods and raise more food.

  In 1900 each farmer provided enough food to supply seven other people. He lived a life of toil that few Americans today would understand or willingly tolerate. Now one farmer grows enough food for almost 20 other people—and takes far less out of his own hide doing it, thanks to oil.

•

- It is estimated that one-half of everything we enjoy above the subsistence level of living is attributable to savings in time and cost resulting from the use of cars, trucks and tractors in commerce and industry. How many of these modern modes of transportation would be on the road today without oil products?

•

- Oil and gas provided the basis for 25 percent of the nation's total chemical production in 1955—and for 80 percent of all the organic chemical output.

•

- Per capita consumption of oil in the U. S. is 20 times as much as in the rest of the world, and 67 percent of the total energy requirements of the U. S. are now supplied from oil and its products. In part this is due to the plentiful supplies developed by an aggressive industry. In part, also, it is due to making this highly versatile form of energy available at low cost.

•

- In 1955, the U. S. accounted for 57 percent of the world's refining capacity. Western Europe accounted for 15 percent. Today, however, about 60 percent of the refining and petrochemical plants being constructed or planned are outside the U. S.

•

- Some 8 million homes in the U. S. are now heated by oil, and we are raising a whole generation of young people who would never think of associating a snug house with an ax or shovel.

•

Remember: Oil can't speak—you can. Only you can give the non-oil public the true facts about your oil industry.

A Quick Look at the Industry THIS MONTH

Sagging "Oil Lift" Needs Refiners' Help . . .

U. S. "oil lift" to Europe is in trouble. Domestic shipments of crude and products dropped from 573,000 bpd in December to 275,000 bpd in second week of January. Europe's industry is in a bind—and will be for about 60 days.

Result: Government experts are asking oil industry to boost European exports in following manner:

- Cut refinery crude runs 200,000 bpd.
- Adjust yields to reduce gasoline output, increase fuel oils to meet Europe's needs.
- Increase U. S. crude oil production.

Reasoning behind request: With gasoline stocks at record levels, yields can be cut without endangering supply. Effect would be same as exporting products instead of crude.

—•—

Will New Price Hikes Hold? . . .

Oil industry's first crude price boost since 1953 has brought condemnation from all corners. Reactions to one-cent gasoline boost are just as unsavory.

Vote-minded politicians, fast to pick up the ball, are pressing investigations from every direction. Sen. Kefauver requested $300,000 for Senate antitrust investigation—Senate Commerce Committee asked for $50,000 for its study—20 Senators are pushing legislation to set up special Senate investigating committee.

If stocks don't get out of hand when Suez re-opens, predictions are that new prices will stick.

—•—

Postings on Octane Race . . .

Premium gasoline started '57 with national weighted octane average of 97. Highest premium sample tested 100.3 octane. Regular gasoline averaged 90 octane, with highest sample testing 94.7.

Two more cars (Pontiac and Rambler) are going to fuel injection. If trend continues—and it more than likely will—refiners will have to re-evaluate motor fuel specifications for octanes and volatility.

Higher octane costs are being felt at retail level, with no increase in profits. Likely result: Gasoline advertising will steer away from octane pitch, plug highest grade (super premium) for only the select cars.

—•—

Crude from Shale and Tar Sands . . .

Canada's Royalite Oil Company is building 20,000-bpd centrifugal process plant to make coke, sulfur and crude from tar sands. Expected date of completion: 1960. Cost: At least $50 million. Estimated reserves in Alberta's tar sands: 300 billion barrels.

Union Oil's Grand Valley, Colo. shale oil plant is expected to be producing crude by spring. Spokesmen foresee tapping of Colorado's 400 billion barrels of shale oil reserves at the rate of 2 million bpd as definite possibility.

A Quick Look at the Industry (continued)

Refiners Hit By Steel Plate Shortage . . .

Shortage of steel plate will continue for months, even years. Backlogs of orders are piling up. However, technological advances in refining and petrochemicals are requiring increased amounts of quality alloys and clad steels in plate gages. When properly applied these materials serve as current solution to heavy plate shortage.

—•—

New Tool for Refiners . . .

Indiana Standard's new end point recorder is paying off in reduced costs, improved products. Instrument measures temperature at which heaviest components of an oil product vaporize. Installed at processing unit, it permits operator to test samples frequently. Testing is fully automatic after sample is put in recorder.

—•—

Atom and the Refiner . . .

Latest atomic energy survey shows seven oil and petrochemical companies have radiation research centers. Most of the companies have pulled out of reactor picture—only one has contracted for a power-type reactor and another for a research reactor.

—•—

JP-5 Demand on the Upswing . . .

Look for JP-5 jet fuel demand to jump 4000 bpd this year. Reason: JP-5, unlike JP-4, is kerosine type and can be stored in skin tanks like diesel. Also, specs on JP-5 will be more rigid on freezing point—minus 55 F. instead of minus 40 F.

—•—

Asphalt Boom Is Shaping Up . . .

Refiners are keeping close watch on mammoth highway building program. Latest estimates are that federal, state, county and local governments will spend more than $100 billion on roads in next 13 years. About half will be federal money.

Highway spending will reach $5.8 billion this year, compared with $5.1 billion in '56. Figure may top $8 billion by '60.

—•—

For the Record . . .

Every minute of the day, more than 105,000 gallons of gasoline are used in the nation's vehicles, planes, tractors, boats and industrial engines. Estimates are that there will be at least 31 million new gasoline buyers in next ten years.

—•—

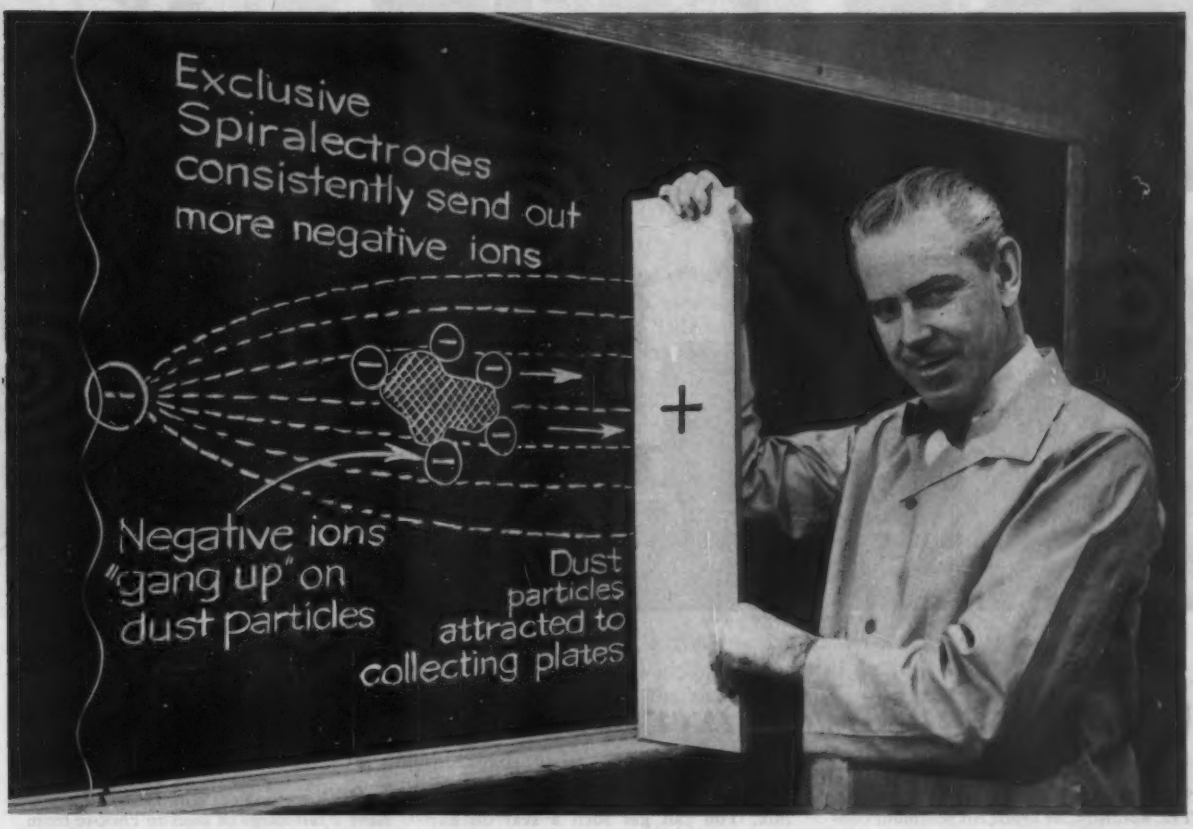
Wildcats Show Promise . . .

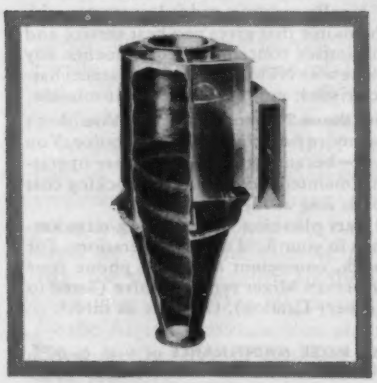
The final month of 1956 saw 81 new oil fields added to the nation's ledger. As usual, the majority was important collectively only. Several standouts were included, with the most promising being a new find in Montana.

The discovery, one of the best in the state's history, was made by Amerada. It was Sheridan County's first and was good for 2742 barrels of 40-gravity oil daily.

Other discoveries of note were: Anderson-Prichard's Cleveland County, Oklahoma, well flowing 650 barrels of 40-gravity oil a day; Gulf Oil's 527-barrel, 36-gravity, find in Pecos County, West Texas; Tennessee Gas' Lea County, New Mexico, discovery good for 413 barrels of 41-gravity; a test drilled by Simpson Hines Oil in Throckmorton County, North Central Texas, making 528 barrels of 43-gravity oil, and an offshore strike in the South Timbalier area, Louisiana, by Gulf Refining testing 346 barrels of 31-gravity oil a day.

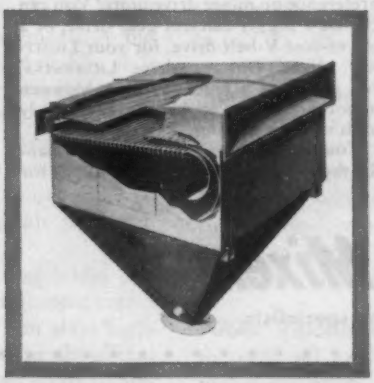
How a Buell Collection System "gangs-up" on dust to meet the toughest air pollution codes





Buell Cyclones also deliver extra collection efficiency to "gang-up" on dust: Exclusive Shave-off design harnesses double-eddy current and puts it to work.

With positive gas flow control for peak efficiency . . . plus continuous cycle rapping to eliminate puffing . . . Buell's "SF" Electric Precipitator really "gangs-up" on dust (even dust with high resistivity) to permit full production even under the most rigid anti-air-pollution codes.



Buell's Low Resistance Fly Ash Collector combines high efficiency to meet present day strictness, with low draft loss for natural or mechanical draft installations.

FOR THE COMPLETE STORY
Write:

Buell Engineering Company
Dept. 21-B, 70 Pine Street
New York 5, New York

buell

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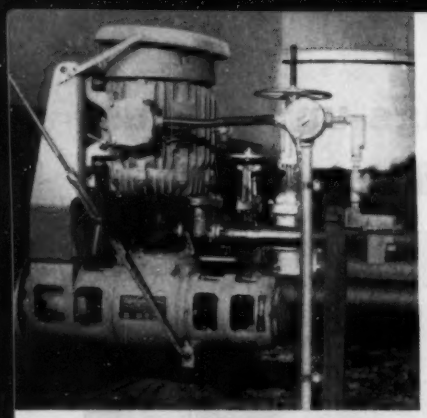
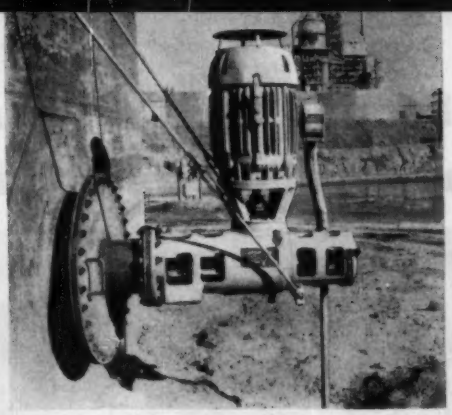
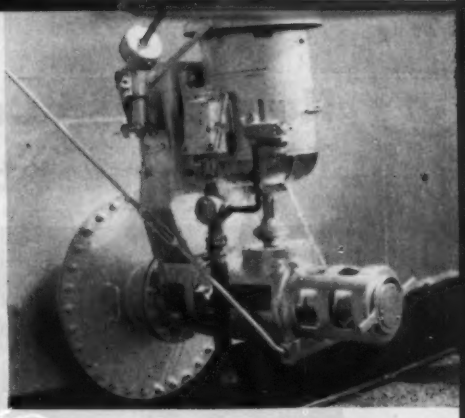
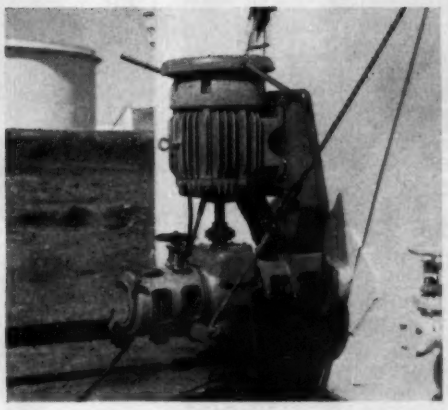
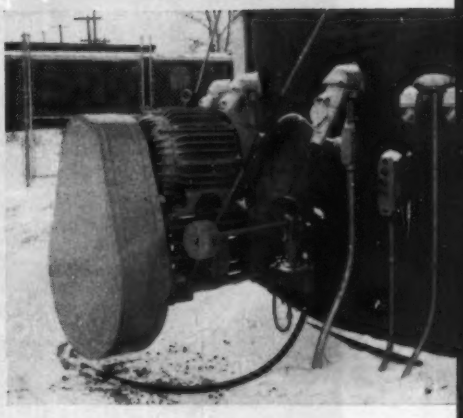
Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**

Puzzle: *find the mixer that costs least to operate*

Specifying the *right* mixer for blending, TEL addition, or crude oil sediment control may *look* like a puzzle—but it doesn't have to *be* one.

Simply look for the mixer that gives you *most choice* for the money. That's the one most likely to give you the long-run economy you're seeking.

For example, if corrosion is a problem, you'll want a free hand in choosing the material for the mixer shaft and propeller. It's good to know you can get these parts in *any* machinable metal or alloy (and with special covering, if you want it) —when your choice is a LIGHTNIN Mixer.

Leak-free sealing—Perhaps you've taken a close look at maintenance costs, and decided you'd like a mixer with a rotary mechanical shaft seal instead of a stuffing box. You can get such a seal on any LIGHTNIN Side Entering Mixer (it's saving many oil companies thousands of dollars a year on maintenance). Or you can take your pick of *four* standard packed stuffing boxes, two of which permit repacking without draining the tank.

Choice of power input—What's your preference on mixer drive units? You can choose a highly efficient gear drive, or a lower-cost V-belt drive, for your LIGHTNIN Mixer. On gear-drive LIGHTNINs, you can have a fluid coupling between motor and drive to handle excessively high starting torques.

You want a mixer big enough to handle the job. But you *don't* want to pay for excess horsepower. With LIGHTNINs, you have a *full range* of sizes to choose from —18 basic models, 1 to 25 HP.

Finally, you can order LIGHTNINs with the motor that gives you best service and minimizes your stock requirements: any make with NEMA frame; any current characteristics; any enclosure or insulation.

Get these 20-year savings—You don't pay more for this freedom of choice. You *save*—because you cut your mixer operating, maintenance, and parts-stocking cost for *as long as the next 20 years.*

Start planning *now* for long-term savings in your fluid mixing operations. For quick, competent help, just phone your LIGHTNIN Mixer representative (listed in Refinery Catalog). Or write us direct.

CUT MIXER MAINTENANCE as much as 60% with the new LIGHTNIN cartridge-type rotary seal, optional with LIGHTNIN Mixers. It positively stops leakage, runs for years without adjustment—and slides off the shaft for fast, easy replacement if ever necessary.

Lightnin® Mixers

MIXCO fluid mixing specialists

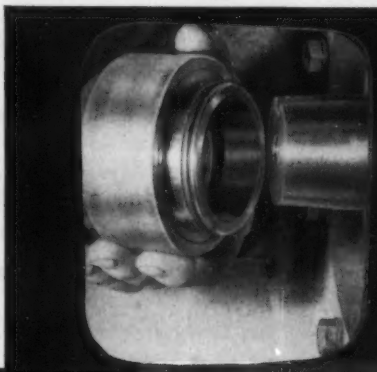
FOR LATEST MIXING INFORMATION and full description of LIGHTNIN Mixers, send for these helpful bulletins:

- ☐ B-102 Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP
- ☐ B-103 Top entering; propeller types: ¼ to 3 HP
- ☐ B-108 Portable: ⅛ to 3 HP
- ☐ B-104 Side entering: 1 to 25 HP
- ☐ B-112 Laboratory and small-batch production types
- ☐ B-109 Condensed catalog showing all types
- ☐ B-111 Quick-change rotary mechanical seals for pressure and vacuum mixing
- ☐ B-107 Data sheet for figuring mixer requirements

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 164-b Mt. Read Blvd., Rochester 11, N.Y.

In Canada: Greey Mixing Equipment, Ltd., Toronto 10, Ont.



Velvet Ribbon, Not 'Black Sheep'

TO THE INDUSTRY, ASPHALT has been a black sheep from the time we started producing it. To the process man, there wasn't much challenge in the processing scheme; to management, there was never much trouble meeting the demand. It's still true that the process needs no major revamping and that the industry can easily meet demand. So why boost asphalt?

Spectacular Demand. One good reason to be an asphalt booster is that its demand will increase 50 percent in the next four years, if the oil industry will only make an ordinary effort to sell it. With this demand, estimates are that present production of 260,000 barrels daily will increase to more than 320,000 barrels daily. Mostly, the jump will be due to the federal aid highway program.

Asphalt will be competing with its old rival, concrete, for highway paving demand. Asphalt has a good case, since 80 percent of present roads are paved with asphalt. Even more significant is that the modern turnpikes (the type of highway that the federal program will be sponsoring) are paved with asphalt in most cases. More than 700 miles of asphalt-paved toll roads are proving financially and structurally sound. By the end of 1957 more than 1000 miles of asphalt turnpikes will be in existence. That's product acceptance that we can crow about.

Asphalt's case can be built on the lower initial cost of a flexible or asphalt-type pavement. A big variable is the soil condition; where favorable, it is actually possible to build three miles of flexible pavement as against one mile of the rigid or concrete type for the same price. In the less favorable cases, the saving is still 20 to 30 percent. It's been estimated by the Asphalt Institute that about $3 billion can be saved in the federal program if asphalt is chosen over concrete.

Even concrete spokesmen concede that initial cost will be less with asphalt, but the big argument comes over the cost of maintenance. Data from state highway departments can be maneuvered to show that either concrete or asphalt is the cheaper to maintain. It depends upon how well the roads were constructed originally. Asphalt suffers in some comparisons because poor construction methods were used to keep within a rigid budget that ruled concrete out completely. However, where good construction was followed in each case, asphalt is shown to be the cheaper material to maintain.

Good Example. Among the modern turnpikes, a good case in point is the Pennsylvania Turnpike. It was built of concrete in 1940. By 1954, parts of the turnpike had become so expensive to maintain that 22 miles of it were resurfaced with asphalt. In 1955, another 37½ miles had to be resurfaced with asphalt; and in 1956 with the addition of 40 miles more, the grand total of 100 miles of the concrete turnpike had been resurfaced with asphalt. On the other hand, the maintenance on asphalt turnpikes has been very low.

One of the old arguments against asphalt pavements was that they could not withstand the heavy traffic of modern highways. The recent Washo Road Test has disproved this completely. It was sponsored by the Western Association of State Highway Officials, thus giving an unbiased authority to the study. Here are the significant findings of this 18-month test:

- Asphalt pavements of the types commonly constructed on primary highways today can carry the heaviest legal truck loads without distress.
- Asphalt pavements currently constucted on primary highways can support, without distress, the heaviest trucks during the critical thaw periods.
- Paving the shoulders of asphalt roads will greatly increase the load carrying capacity of the roadway and reduce the cost of maintenance.

Besides all-weather durability, asphalt can add smooth-riding comfort and safety to its list of attributes.

More Gasoline. The oil industry has a big stake in the quality of the highway program, because if our roads are better, people will drive more. That means a bigger demand for gasoline and lubricants. Further, it will take a lot of petroleum products to run the equipment that will build these roads—estimated at 20,000 barrels daily more than now used in highway construction.

Public Relations. It also does the industry good to point out to the public a petroleum product that makes life easier. You cannot call asphalt a miracle product or an atomic-age invention, but it certainly is a bargain product that does its job well. Instead of calling it the black sheep, we could go along with the Asphalt Institute and call it "ribbons of velvet smoothness."

Infinitesimal You. If you boost asphalt, you're

An empty bottle . . .

clue to deposit-free heating and diesel fuels

In Du Pont Fuel Oil Additive No. 2 (FOA-2) you'll find not only an effective stabilizer and sludge dispersant, but an additive that's *ashless.*

The above picture shows the amount of ash left after burning four different additives. The bottle on the left contains the almost invisible amount of ash that would remain after burning 1,000 gallons of fuel oil containing Du Pont FOA-2—at a concentration of 20 pounds per 1,000 barrels. The other bottles contain the ash left from burning a cost-equivalent concentration of fuel-oil additives having metallic components.

Why use an ashless additive?

In the operation of oil burners or diesel engines, ash deposits can obviously interfere with proper functioning. For example, stack-control failures—brought about by metallic ash deposits on a helical coil—can lead to needless and unprofitable service calls.

Examination of many diesel locomotive exhaust-stack accumulations shows them to be composed largely of metallic ash . . . up to 98.7 wt.%. This creates a sparking hazard. However, when FOA-2 is used to prevent injector sticking and filter plugging in economy diesel fuels, the additive does not contribute to this hazard.

Write to any of our offices listed at right for further details about this versatile ashless additive.

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Better Things for Better Living . . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & CO. (INC.) • Petroleum Chemicals Division • Wilmington 98, Delaware

sure to get more road for your tax money and a better ride for your own car. Put another way, your taxes and car repair will be less because here is an economic product with which to build good roads. And what's more, when the roads are completed, it will be a pleasure to drive on them—something slighty intangible but very important on those future vacation trips.

Goal Achieved By API

WHEN ASME ADOPTED its pressure vessel code back in 1925, refining engineers protested that it was much too conservative. Refining experience showed that the adopted safety factor of five was too high; four would be more reasonable. But ASME stood pat; the safety factor stayed five.

That's when API came into the picture. Working through the API, these refining engineers took steps to write their own code. The influence was felt and ASME proposed that the two groups draw up a special joint code covering pressure vessels for the petroleum industry. API agreed. In 1931, the Joint API-ASME Committee on Unfired Pressure Vessels was created and three years later it published its own specifications. Now there were two codes—one for industry in general and one for the petroleum industry in particular. At best, this was a compromise.

Besides the difference in safety codes, the API-ASME code allowed the purchaser to inspect his own vessels while the ASME code permitted only independent agencies to do so. Other differences were on less essential matters; but with the two major differences, the petroleum industry chose to live by the API-ASME code.

By 1950, proof had piled up that the joint code was as safe as the other, so ASME modified its original position. They prescribed a safety factor of four and permitted the purchaser to inspect his own vessels. That brought the codes so close together that the Joint Code was discontinued at the end of 1956.

It was a dollars and cents victory for API and the petroleum industry. The reduction in the safety factor represents an estimated savings of 15-20 percent or $45 to $60 million annually. For all U. S. industry, the figure might be over $75 million. Our congratulations to API.

Accentuate the Initiative

THE OIL INDUSTRY again has failed to take the initiative in telling the nation its side well in advance of a major action. Last year it was the Harris bill. This year it is price increases.

The results:

- The Senate Commerce Committee has requested $50,000 to study recent price increases.
- Tennessee's Estes Kefauver has requested $300,000 for an all-out antitrust investigation which will include the recent price increases, among other issues.
- Twenty senators are supporting legislation to set up a special Senate committee to investigate—yes, that's right—the price increases.

This all adds up to the same uncomfortable situation that caused the industry so much agony with the Harris bill: *The oil industry is on the defensive.* And, from all appearances, it will be on the defensive more than once this year.

Past experiences should have pointed up that it is expensive constantly to be on the defensive—and serves only to give oil's critics new levers for added government controls.

Although the opportunity has been lost to take the initiative regarding the price increases, there is still time to tell oil's side of the remaining major issues that will appear on the national docket this year. Let's tell oil's side of the depletion provision and gas bill—not to ourselves—but to the public and the nation's lawmakers. And tell it far enough in advance!

A good place to start would be the industry's two million employes. Keep them informed so they will know the facts when talking to non-industry friends. This one group will be a powerful force in behalf of oil—if it is equipped.

To borrow an old admonition let's "*accentuate* the initiative—*eliminate* the defensive."

U. S. Oil Scene Has Brightened

THE OUTLOOK FOR U. S. OIL is considerably brighter than seemed possible a few months ago. Crude oil stocks' excess has been drawn off by European needs, gasoline inventories have recently shown improvement, and distillate fuel oil supplies are in good position.

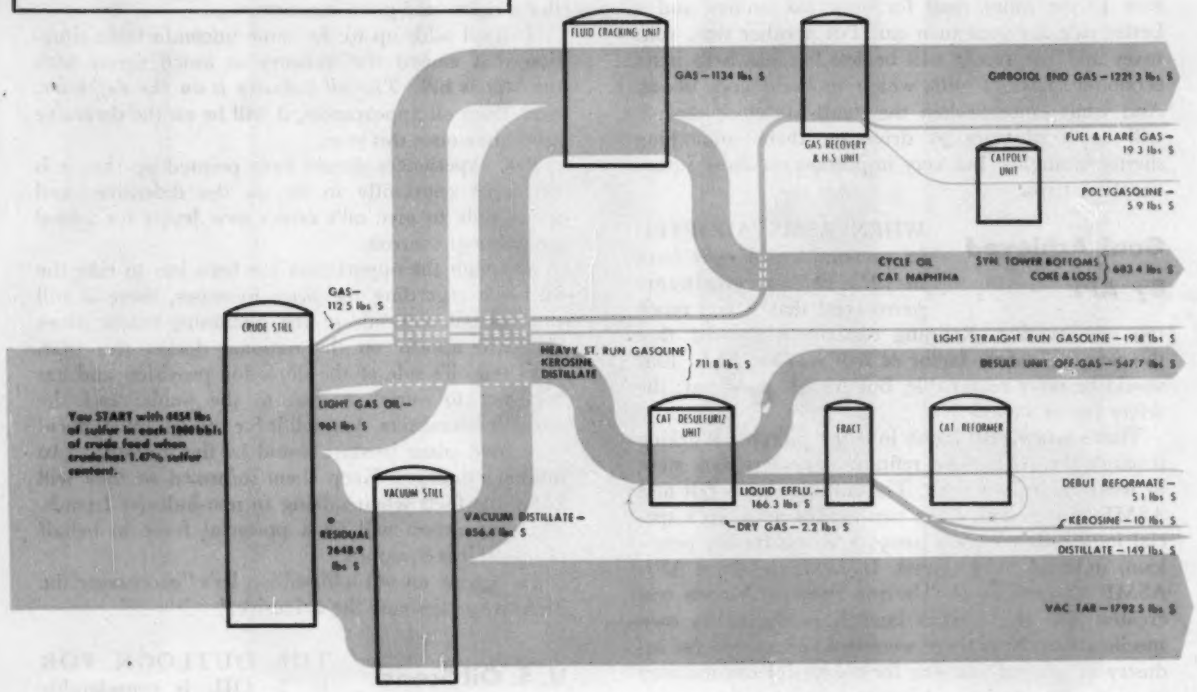
Gasoline stocks are still high, and, of course, will continue to grow through March, but the latest inventory count showed encouragement. On January 18, API reported that gasoline supplies amounted to 191,373,000 barrels. That was 15½ million barrels more than was in tanks a year earlier. Still too much, perhaps, but encouraging was the fact that only a week earlier inventories were 17⅓ million barrels ahead of last year. When the winter's gasoline build-up started in October, stocks were 19⅔ million barrels greater.

Recent weeks have seen lowered runs to refinery stills, and this has resulted in the improved gasoline position. Further cut-backs seem advisable as such a move would certainly bring motor fuel output back to a more realistic level for this season of the year.

Although several months remain in the heating season, there would appear to be no danger of running short of the heating oils even if refining activity was further reduced. At present, distillate fuel supplies amount to 20 million barrels more than was on hand a year ago. These oils began the heating season with only a 6-million-barrel advantage over the year before.

Now is the time for industry wisely to manage its economic affairs. The current situation provides a splendid opportunity to regain a firm economic footing.

Where the Sulfur Goes


FLUID CRACKING UNIT
GAS – 1134 lbs S
GAS RECOVERY & H.S UNIT
GIBBOTOL END GAS – 1221.3 lbs S
FUEL & FLARE GAS – 19.3 lbs S
CATPOLY UNIT
POLYGASOLINE – 5.9 lbs S
CYCLE OIL
CAT NAPHTHA
SYN. TOWER BOTTOMS
COKE & LOSS
603.4 lbs S
GAS – 112.5 lbs S
CRUDE STILL
HEAVY ST. RUN GASOLINE
KEROSINE
DISTILLATE
711.8 lbs S
LIGHT STRAIGHT RUN GASOLINE – 19.8 lbs S
DESULF. UNIT OFF-GAS – 547.7 lbs S
You START with 4454 lbs of sulfur in each 1000 bbls of crude feed when crude has 1.47% sulfur content.
LIGHT GAS OIL – 961 lbs S
CAT DESULFURIZ UNIT
FRACT
CAT REFORMER
VACUUM STILL
RESIDUAL 2648.9 lbs S
VACUUM DISTILLATE – 856.4 lbs S
LIQUID EFFLU. – 166.3 lbs S
DRY GAS – 2.2 lbs S
DEBUT REFORMATE – 5.1 lbs S
KEROSINE – 10 lbs S
DISTILLATE – 149 lbs S
VAC TAR – 1792.5 lbs S

How to save up to 7¢ per barrel on lead

Ethyl Research studies show you can increase the octane number by decreasing the sulfur . . . and use less lead!

Getting the most from your lead is a complex business involving among other things, hydrocarbon blending and control of sulfur concentration in the fuel to be leaded. The Ethyl Corporation is constantly studying the interrelation of all the variables which affect lead utilization.

The antagonism of sulfur and tetraethyllead has long been known, but the refiner's problems today are 1) how much sulfur can justifiably be removed on the basis of savings in tetraethyllead and 2) what process can best be used to remove this sulfur. The advent of large volumes of high-pressure hydrogen at relatively low cost as a by-product of catalytic reforming processes has altered the entire economic picture of sulfur removal.

Actually the over-all justification of sulfur removal at one point or another in the refinery is composed of a number of complex factors including:

1. **Decreased product odor**
2. **Decreased refinery corrosion**
3. **Lessened refinery operating problems**
4. **Improved color and lessened gum formation**
5. **Improved tetraethyllead response**
6. **Sale of recovered sulfur**
7. **Avoidance of catalyst poisoning**
8. **Improvement in lube-oil life in the engine**

Of these various factors, perhaps the easiest to assign dollars-and-cents justification to (and certainly the one with most widespread application) is a saving in tetraethyllead.

Figure 1 shows the effect of the type of sulfur compound on Research octane number loss. This plot is based on U.S. pool gasoline which has a 79.2 Research octane number clear and a 92.0 Research octane number with 3 cc. of lead, and which contains 0.075 per cent total sulfur which may take the

For more data on advertised products, use Readers' Service Cards, last page.

form of the various compounds shown below.

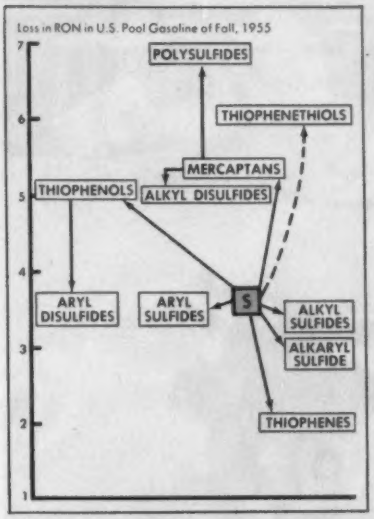


Fig. 1. *Effect of type of sulfur compound on RON loss*

Actually, a reasonable assumption would be that gasoline contains half monosulfide sulfur and half thiophenic sulfur. Complete removal of this sulfur, although economically attractive, is a practical impossibility. With the advent of hydrogen treating, however, there is no reason why 50% sulfur removal cannot become a reality. Figure 2 illustrates the TEL savings which are possible with 100%, 75% and 50% sulfur removal from U.S. pool gasoline of 91 RON with 2.38 ml. of TEL.

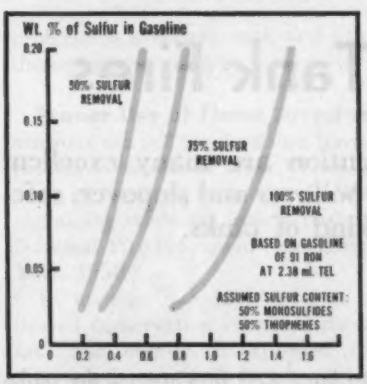


Fig. 2. *TEL savings (ml. per gal.) with sulfur removal*

The average refiner, while he may be interested in the above data, still wants to know, "What's in it for me?" and Figure 3 answers this question. Here the possible savings in cents per barrel of gasoline are shown as a function of the weight per cent sulfur in the gasoline pool. This relationship is independent of the lead susceptibility of the particular stock and of the Research octane number level. Here, again, we are assuming half monosulfide sulfur and half thiophenic sulfur, and the economics of 50 and 75 per cent sulfur removal are shown for TEL levels of 1.5 and 3.0 ml/gallon.

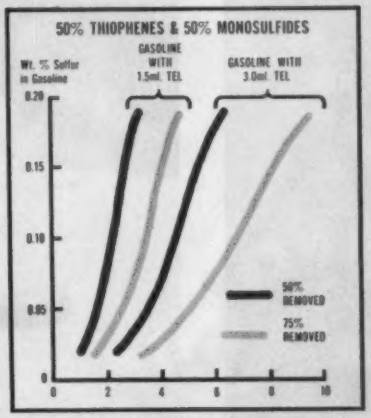


Fig. 3. *¢ per bbl. savings possible*

For example, it can readily be seen that a pool gasoline requiring 3 ml/gal of TEL and containing 0.10% sulfur could meet the same octane specifications with a saving in TEL cost of 7 cents per barrel if 75% of the sulfur were removed.

It is not unreasonable to assume that pool octane number could be raised one unit by desulfurization. Current octane-improvement costs, as shown by recent Ethyl studies, range as high as 16 cents per Research octane number per barrel. Therefore, 16 cents per barrel could be considered a justifiable expenditure for desulfurization on the basis of Research octane quality alone. Your justification will depend on the conditions specific to your refinery.

The optimum operation of your refinery to permit you to make the most of your lead could be the subject of a profitable discussion with your Ethyl refinery technologist. Your Ethyl Representative will be glad to arrange an appointment for you.

What Ethyl Research offers you

At today's high octane level, the advantages of getting more efficiency from your lead have taken on more and more importance. To complement the intensive effort which the industry is devoting to this problem, Ethyl Research is continuously studying how the hydrocarbon blending and sulfur removal factors can lower lead requirements.

We are constantly testing and probing all the variables which affect lead utilization in today's high-compression engines. The problem of sulfur removal and the sudden entrance of high-pressure hydrogen, as a by-product of catalytic reforming, into the economic picture is being watched very carefully at Ethyl Research. Write to Ethyl Corporation, Box 14, for a copy of "Sulfur in Gasoline—an Economic Appraisal"—another in the continuing series of reports from the Ethyl Corporation on fuel blending and other studies of vital interest to refiners today.

For further information, just call your Ethyl Representative. He'll be happy to arrange an appointment for you with one of our Technical Representatives.

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FIGURE 1—As the temperature of an oil rises, the vapor pressure increases and must have unblocked relief or pressure rupture may occur. There is no flame arrester in the opening of this drum.

FIGURE 2—Conservation vent with no flame arrester bank. Flame arresters are not needed on approved conservation vents. They are themselves effective flame arresters, as well as vapor conservation devices.

Safety and Fire Protection—Part 2

How to Prevent Crude Oil Tank Fires

In this thorough summary of crude fire prevention are many excellent pointers on the proper use of flame arresters, prevention of boilover and slopover, safeguards against lightning ignition and the use of the right kind of tanks.

J. L. Risinger
Maplewood, N. J.

FIRE DIFFICULTIES, inherent in the characteristics of crude oil when stored in tanks or pools ,are rapidly being overcome by:

- More effective means of handling the slopover characteristics of crude.
- Improved fire extinguishment methods.

These two avenues of progress in crude oil fire prevention and control are reflected in the following industry developments:

Using the Right Kind of Tanks—All steel gas tight capacity vented tanks are not subject to lightning ignition. The cause of fire is limited to spontaneous ignition from iron sulfide accumulation above the liquid level from storage of high sulphur crude, exposure to fire from outside sources and to large spill fires around the tanks.

By the use of conservation vents on low flashpoint cone roof crude tanks, iron sulfide formation is usually kept dampened with vapor and therefore inactive. Thus, the fire problem is limited to times when the tank is out of use. Attention should always be given to preventing the drying out of tanks having contained high sulphur content crude.

In the case of storage exclusively of sweet crude oil in a tank, iron sulfide ignition is eliminated.

The floating roof tank, in addition to conserving crude oil vapor, has limited crude fires to a few lightning ignited rim fires that were easily put out. With some corrections even this cause can be eliminated.

In short, the greatest factors in solving the tank fire

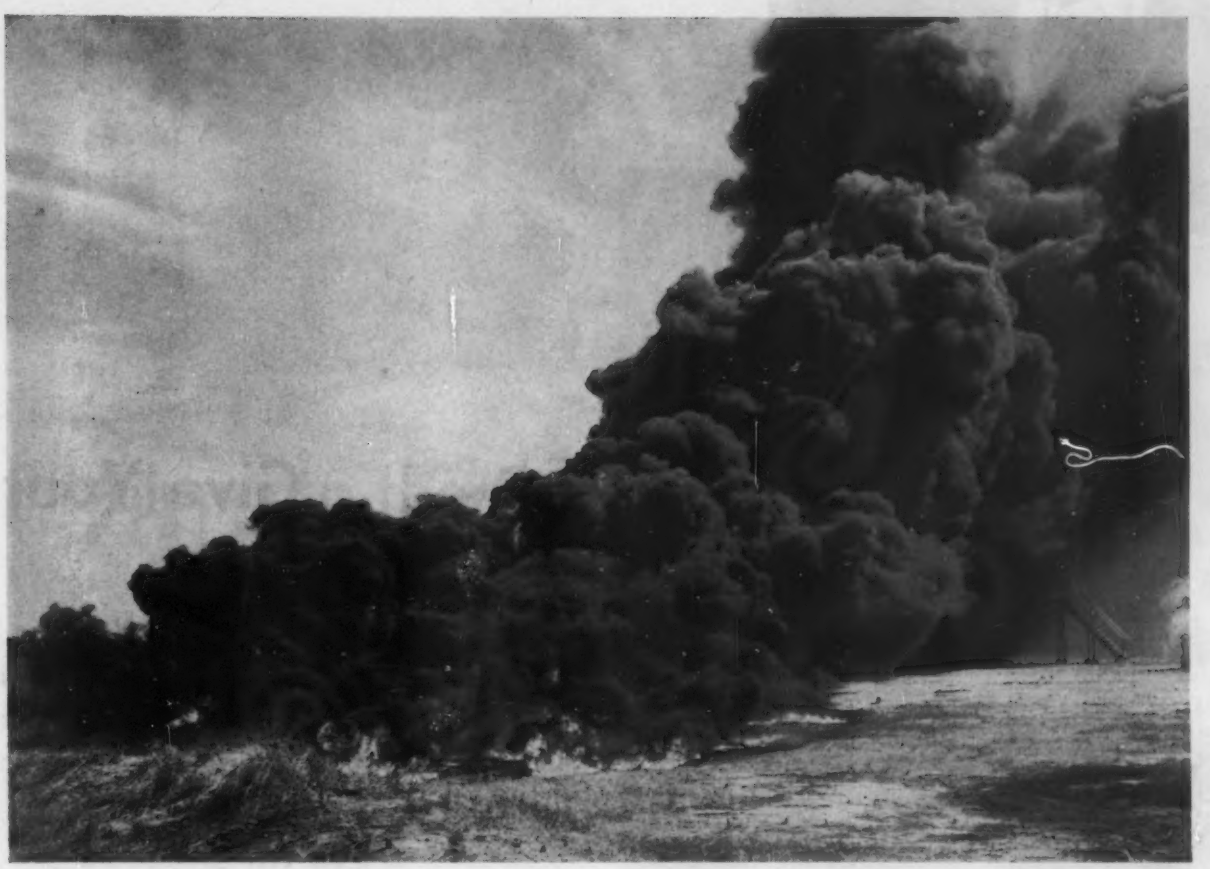


FIGURE 3—In this air agitation test, application into a four-inch water bottom caused the crude to boil over after 1½ hours of burning. A similar tank with the same oil had a heat wave about 50 percent of the depth of the oil.

problem is a correct tank and keeping the tank correct through proper maintenance.

Proper Use of Flame Arresters and Vents—Flame arresters are not required and have no purpose on an approved conservation vent. They are required on open vents of crude oil tanks of over 3000 barrels capacity and containing crude oil with a flashpoint below 70 F. (See National Fire Protection Association ordinance, No. 30-L, May, 1954.)

In no case is a tank required to have both the approved conservation vent and the approved flame arresters. The opinion is expressed that neither vents nor arresters are justified on all steel gas tight tanks. However, the approved conservation vent is well justified on tanks containing low flashpoint crude oils to help prevent loss of vapors.

Flame arresters on these vents are not required and cannot be justified in the light of oil industry experience. They greatly reduce the venting capacity, are difficult to keep from clogging, may cause a tank roof rupture and their cleaning and upkeep presents a problem in any climate.

Provisions for Spill and Overflow Control—Increased dike capacity is no insurance against spread of fire from boilover of crude oil. More attention should be given to modern methods of preventing the fire and extinguishment without slopover. Also, the fires must not be permitted to burn to a boilover.

Some regulations provide that tanks or groups of tanks containing flammable liquids be diked or other suitable means taken to prevent spillage or overflow of liquid. With present methods for extinguishment of crude oil tank fires, no extra provisions are indicated above that of refined oils.

Where terrain is suitable, the trend is toward channeling of liquid to an area where spillage or overflow will not become ignited and fires can be extinguished or allowed to burn. This method is replacing the diked enclosures in many instances.

Diversion dikes are used where necessary to direct the flow to open depressions, ditches or closed drainage systems. For specifications where diked enclosures are required, see National Fire Protection Association Handbook 30-L.

Added Requirements for Crude Oil Storage Tanks—Crude oil tanks in or near refineries are either all steel gas tight capacity, vented or floating roof tanks. Therefore, the incidence of fires to these tanks is remote.

Should one of these cone roof tanks blow the roof and catch fire, it can be put out with portable equipment before a slopover heat wave develops. There is no reason why one of these cone roof tanks should be permitted to

Continued on Page 222

A Special Report . . .

RECENT ADVANCES in data processing now give our industry a very important tool—the high-speed electronic computer. This tool will help us utilize our vast storehouse of technical knowledge.

The experts differ on the approach which should be used to put the computer to work. Some think computers should start by solving the important problems of top management. Others believe they should be proven by applying to less far-reaching problems. In either case, the computer is sure to become an everyday part of our industry.

Some say that speed is not the important characteristic of the computer. Nevertheless, it is this attribute which permits the computer to do one of its most worthwhile jobs—explore the unknown. With it, we are able to perform tremendous quantities of computations. We can explore on paper the many variables which have been overlooked heretofore.

The computer is capable of turning out very accurate answers at a frantic speed, but it is equally capable of producing grossly erroneous results at the same rate. This makes it very important to understand the ways of the computer.

On the following pages are presented reports by persons who are active in the computer field. Bartow Hodge, for example, discusses how to organize both problems and personnel in a computer program. David Rubinfien and Ralph F. Lewis give the results of a survey of 25 major oil companies in order to discover the ways to best use computers. Dr. Grace M. Hopper then suggests that tomorrow will bring us a library of programs to make easier the transition from problem statement to computer setup.

Next we turn to some particular applications of analog computers. An article by Robert S. Schechter and another by H. H. Yang give some engineering problems, and show how to program the analog computer to handle them.

The future holds much for the computer. It is expected that these machines first will take over a great deal of the routine calculations now being performed by hand. Thereafter, the sky is the limit. It will remain for our ingenuity to conceive of jobs for the computer, to resolve situations into mathematics, and to judge operations in the light of our formulae.

Harold L. Hoffman

Give Your

Here is a discussion on how various problems are prepared for the computer and how to organize personnel to handle the computer operations.

Bartow Hodge
International Business Machine Corporation
Baton Rouge, Louisiana

COMPUTERS ARE NOT A PANACEA for all of industry's problems. Nevertheless, they can take over a great deal of our work if the problems and personnel are organized into a smooth working setup.

The experts say that a computer is not a "many splendored thing." It is just another tool which can be very valuable if used correctly. For this reason, computer-consciousness is growing fast in the petroleum processing industries. Scarcely a month passes without some company announcing a new computer program as part of its operation.

What can be gained from computers? How can they be used? Will they save money or reduce needed technical manpower? Answers to many questions like these have appeared with increasing rapidity in recent months.

Agreement is unanimous that technical people are overburdened with tedious, voluminous, routine calculations. A well-planned computer program can relieve this burden, giving technical persons more time to formulate problems and evaluate results. All possible alternates to a given problem can be examined completely by a computer, helping to signal the optimum answer. Horse-and-buggy hand computations could check only a few of the many alternates.

Problems to the Computer

So, you have a problem. *Is the problem suitable for computer solution? How do you define this problem for a computer?* The answers to these questions are attempted and ideas on how to start a computing activity in your organization are given.

Types of Computer Problems

Computer problems may be broken down into five types. These are:

1. Scientific Problems in which you have a numerical or mathematical model rather well defined. Examples are partial differential equations, matrix manipulation as in Mass Spectrometry or Infra-red Calculations, or the solutions of a set of simultaneous equations.

2. Business Problems, as payroll, inventory control, personnel accounting, and similar problems.

3. Simulation Problems in which we simulate mathematically certain operational units. For instance, simulating a reactor tower to study the results mathematically, simulating a catalytic cracker or an entire refinery from the production and transportation of the crude into the refinery, the refining operation, and the transportation of the output to the marketing facilities. Another example, simulating a tank farm to determine the optimum storage needed, by playing a Monte Carlo type game to check the optimum capacity versus needs under given operating conditions and thus giving management an idea of the best tank farm storage capacity.

4. Automation Problems use a calculator to do the work ordinarily done by human beings. An example is drafting. To make a change on a distillation tower, literally tons of blue prints must be drawn up. Most of there are pipings from *here* to *there*. We could simulate *here* by coordinates X_1, Y_1, and *there* by coordinates X_2, Y_2, in a cartesian plane, then the calculator could be programmed to determine the best method to go from *here* to *there*, essentially as a draftsman would draw it on paper. Thus many of these reams of blue prints are eliminated.

5. Real Time Calculations are the fifth type. An example is automatic feedback and control. If we are measuring the overhead gas stream of a hydroformer unit with a monitor mass spectrometer, we need to know the results of that calculation, use that calculation to feed back pulses for control of temperatures, pressure or other operating variables to control the operation of the unit. In this case, the calculation and the feedback pulse must be in real time, that is, in time to make the necessary control operation. A recent example is the use of a high speed computer to control guided missiles in flight.

Definition of the Problem

So, you have a problem. What is necessary to put this problem on a computer? The first step is a complete problem statement answering these questions:

- **What do we want?** A precise mathematical statement of the results you want. An answer to the output or report format desired in the presentation of the results. The range and precision of the output data, if known.
- **What do we have?** What data are given, what is the form of this data? What is the range and precision of intermediate results, if known, and what is the range and precision of input data, quantity of data, possibility of future runs?
- **How do we want to do it?** Are literature references available? Is this already in the library of applications? Which mathematical method is to be used?

We will expand these ideas. The first step in problem definition is a general problem statement. The general problem statement should tell you what is given, what is to be found, and how to find it. Functional notation should be used where possible, with the explicit form of the functions being given in the detailed problem statement.

With the completion of the general problem statement, the next step by the novice engineer—a novice in the use of computers—is to secure help from a mathematician

trained in computer logic and numerical methods. Often an analytical insight will give the answer with very little computing. A simple change in limits of the data or approximations to the general case may give a feasible solution quickly. Again some problems statements may require much more time for computing than the results are worth. These problems obviously should not be performed.

Suppose, then that it is a good problem, amenable to calculation. The second step in the definition is a detailed problem statement. This would include the range and precision of the input data. By precision is meant the number of significant figures or the number of decimal places. It is perhaps conventional to use the term precision for the number of places carried, and the term accuracy as to whether it was worth it.

Scientific problems are usually easily stated because of the precise mathematical statements defining the answer to the three questions we have asked. Simulation problems, and for an example consider tower design, or the familiar "distillation" problem, are trial-and-error problems in which we need to know the results of previous calculations before proceeding to the next calculation.

The engineer must know the logic of his problem. What is the basis for the first "guess" or trial? On what basis do we make the second guess and so forth? These logical decisions must be spelled out exactly for the "moronic brain" called an electronic computer. The best person to answer these questions is the engineer with the problem.

Years of specialized experience in the engineering fields most often are not passed on to the programming specialist. From experience, the engineer may know that the limit on a certain condition is a certain maximum, but the program specialist does not have this knowledge stored in his head, and unless the computer is told the limit, it assumes no limits and may get in trouble.

To summarize, the detail problem statement is a complete write-up containing the input data, the input data format, the output data format, the method intended for solution of the problem, an analysis of the accuracy of the computations, and input, immediate, and final limits on any variables or data.

With this done, the engineer then proceeds to a flow chart, a step by step sequence of operations or logical decisions in the problem solution. By now 90 percent of the work is completed. The coding, the writing of instructions for the machine, can then be accomplished.

It is only fair to admit that one may change many original ideas—even the method of solving the problem —while working out certain intricasies of the flow chart. Similarly, this may happen during the process of coding. One may get ideas which change some of the original plans. Planning, flow charting, and coding are often integrated. However, this merely means that something in the write-up is to be changed: it does not do away with the necessity of the write-up. The write-up reflects all of the original planning of the problem.

At this point the engineer could turn the problem over to someone else for coding if necessary. Having a complete, detailed problem statement and write-up assures a finished write-up after the problem has been written and de-bugged—i.e., the errors corrected. Now one only needs to add the flow chart, a listing of the program and the operating instructions and the problem is ready to run.

All programs should contain restart procedures. A

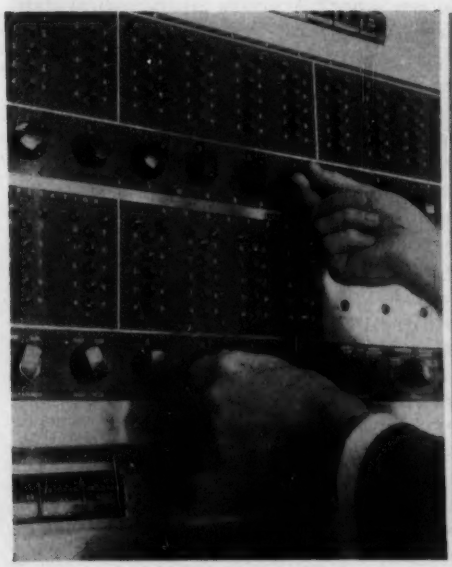


Photo courtesy University of Houston News Service

HOW TO START A COMPUTING ACTIVITY

1. Select a nucleus group of one or two chemical or petroleum engineers who have several years of refinery technical experience. These men should have engineering minds, analytical abilities and aptitudes to deal with abstractions.
2. The first problem solved on the computer should be important enough to demonstrate the worth of a computing activity. Preferably it should be small in magnitude so that results can be realized in a reasonable length of time.
3. If early results are favorable, consider expanding the computing activity into an integrated engineering computer program.
4. If there is an operations research group, it should be in close contact with the computer group.
5. The computer group can be expanded by hiring computer-trained personnel or by expansion from within the group. However, it is best if a majority of the group has experience in petroleum processing.
6. Decide where the computer group fits into the company organization. The group should be somewhat removed from day-to-day operating pressures.

very short computing job might be restarted by starting over. However, one must always expect the possibility of a machine stop (even though this may happen rarely) and provide a method for continuing the computations without having to reperform too much of the computations (timewise). Most often fairly simple procedures can be devised.

Organizing the Computer Group

The organization of a computing service group is varied due to need or tradition. In one case, the programming and coding is done by a highly trained group of programming specialists who function as a buffer between the problem originators and the computer. This form of organization is known as the *closed shop*. In another instance, programming and coding is performed in the *open shop* by the persons who initiate the analysis. Naturally, in either of these cases the computing organization imposed a bias on the mode of programming.

In the closed shop, programming is ordinarily done using the system which will yield a machine language program where the programming group possesses the training and experience to make this approach practical. The additional time requirements on machine language coding are minimized by the skill of the programmers. In the open shop, coding is usually done in an abstract interpretive system whereas the computer is represented by the abstraction as a simpler mechanism, one designed to meet the needs of the problem originators.

Still another organization breakdown has found support. This is the *semi-open shop* operation wherein utility programming and special requests are handled in a closed shop manner, but wherein open shop programming is encouraged. In the semi-open shop groups, coding by the problem originators is permitted whenever possible.

The types of coding systems best suited to an organization cannot be categorically given, however, for the type of application also determines the most effective form of programming machine useage. The small, one-time problem is usually suited to an interpretive programming approach. In some cases, where the program represents an exploration of the physical system, it is often desirable to program in an interpretive abstraction until the application statement is crystallized. Following clarification of the problem statement, it is usually advantageous to convert the program to an efficient machine language code.

In the case of a highly repetitive application, machine language coding is recommended. Also, for large problems, large in machine useage point of view, it is desirable to program in machine language as much as possible.

There are certain advantages and disadvantages for the open or closed shop. In the open shop, you will find a better use of the experience stored in the engineer's head. The engineer, because of his experience is the logical person to run his problem through the computer.

The second advantage in the open shop is that there is a shorter time lag in obtaining results from the problem origination until the results are available. It is the old story—if you want anything done, do it yourself!

The third advantage, better judgment as to the problem best suited for the computers, for the person with the problem knows the problem best.

A disadvantage, however, is that more and broader education is needed. More of the engineers must understand the basic functions of a calculator and the logic involved. There is less control by central authority, that is, less efficient machine utilization. Here, you are sacrificing machine utilization or machine time for an increase in engineering efficiency. Usually in the open shop type of operation, less efficient numerical methods are employed in solutions because the engineer is not usually a mathematical expert. In the semi-open closed shop, however, this can be overcome by using your mathematical experts as consultants to your engineers.

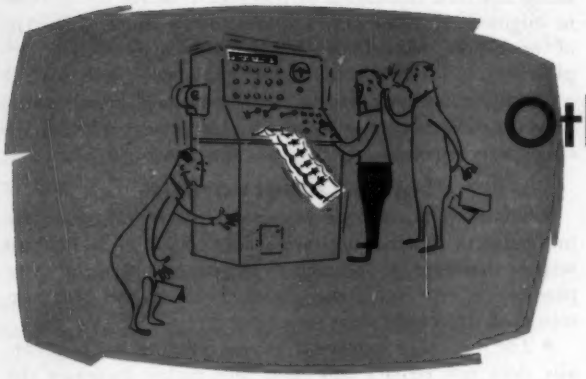
Some Observations

- Considerable time is required for programming the problem—i.e., conversing with the computer. The best return, therefore, is obtained in situations where the same problem is repeated many times, because the programming will need to be done only once.
- The use of a computer in engineering work generally does not replace any men, but rather increases the amount of effective work that can be done by the same staff.
- Besides repetitive jobs, requiring continuous processing of masses of data, use of a computer in a one-time problem will often bring a return greater than the cost of operations analysis, programming and machine time.
- Another important result is that problems and methods are set up for machine solutions that would not ever be considered without the machine. It is difficult to evaluate this factor, or even to estimate what methods are to be used, until experience has been gained with a high speed computer.

The environment in which the petroleum and chemical industry operates is continually changing. "New manufacturing processes develop from an intensive research effort. Available raw materials, specifications for products and the relative demand for them, prices and cost all change rapidly. To keep pace with this rapid change and to be able to respond to it quickly requires the help of advanced computing equipment." ##

About the Author

BARTOW HODGE is an applied science field representative for International Business Machines where he demonstrates scientific and engineering applications of computers to petroleum and chemical problems. Hodge received his B.S. degree in 1947, his M.S. degree in 1948, and his Ph.D. degree in 1954, all from Louisiana State University. He was a physics instructor at L.S.U. from 1948 to 1951 when he joined Esso Research and Engineering Co. in Baton Rouge. He spent the next four years with Esso working on the development and design of automatic and process control instrumentation in the fields of infrared, mass spectrometry, and liquid and gas analysis. Then for the next two years he did research on the physical properties of catalysts using X-rays and other apparatus. He joined IBM in October of last year.



Others Use Computers

From a survey of 25 major oil companies, these data tell how the computers will be used in our industry.

David Rubinfien and Ralph F. Lewis Arthur Young and Company, New York

THE TWO-PRONGED problem of providing management with current, useful information and simultaneously halting the tremendous growth of clerical staff, developing over the past half century, is meeting a formidable challenge today in the application of electronics to data processing in the oil industry. Almost nonexistent five years ago, these techniques are being rapidly absorbed into this industry.

It appears most likely that the next five years will see electronic computer systems in profitable use, not only in each of the companies included in this survey, but also in companies that are much smaller than those covered herein. These installations will be profitable not only on the basis of clerical cost savings, but, more importantly, they will provide management with better facts as a basis for decision-making.

Information for this article was gathered during the latter part of 1955 through a series of interviews with individuals responsible for developing major phases of electronic applications in 25 leading oil companies. Its purpose is to summarize progress and plans in applying electronic data processing and computing equipment to refinery problems.

However, the report was deliberately restricted in its scope to only two of the areas where computers possess high potential for the oil industry: clerical and accounting data handling uses, and engineering and scientific computational uses. The whole area of "automation"—the application of computers as control elements of operations—was regretfully bypassed. Such applications while of universal interest are, understandably, guarded commercial secrets.

The problems of data gathering and reduction, accounting and communication reflect the massive size and unusual complexity of oil industry operations. In particular, refining operations, while usually located at a few principal refineries usually involve large masses of data generated at each refining unit, storage tank and entry to and exit from the plant. Regarded as one of the key areas for electronic data processing, this abundance of detail must be utilized to maintain control of inventory, shipment and operations to develop unit and product costs, and to insure optimum utilization of the plant. In addition to the problems of collecting and reducing the detail data for these functions, each application demands an unimpeded flow of current and revealing information to local as well as to central management.

The marketing areas are similarly confronted with the problem of data sources at every gas station, bulk station, warehouse, and terminal. These sources furnish data, the detail for sales, credit, inventory and costs analysis and for billing operations. The need to "stay on top" of the current situation has led to highly decentralized management at a number of district and regional offices.

Progress to date in the industry has been remarkable. The oil industry is actively seeking answers through electronics to meet the pressing problems of creating information and combating growing clerical costs. Current investment in study, planning and programming and the impressive array of equipment now on order for near-future delivery provide concrete testimony to the vital interest of the oil industry in electronic data processing. Four companies of the 25 interviewed estimated that between $750,000 and $1,500,000 are involved in their studies to date, yet only one large-scale machine and relatively few medium-scale machines have been installed. Another four companies have authorized expenditures of from $150,000 to $500,000 for studies prior to placing an order for any equipment.

in These Ways

Computer Size		How Operating	On Order	Probable Total by End of 1956	Further Orders Being Considered During 1956
Electro-Mechanical (Limited Speed)		6*	1	6	—
Medium-Scale	Computer A	2	—	2	—
	Computer B	3	1	4	—
	Computer C	5	9	14	4
	Computer D	2	—	2	—
	Computer E	—	—	—	1
	Computer F	2	—	2	—
Large-Scale	Computer G	—	5	5	6
	Computer H	—	—	—	1
TOTALS		20	16	35	12

*One to be replaced in near future.

Table 1—Survey results obtained a year ago.

Planning for Electronics

The earliest interest in computers shown by accounting and systems departments was evidenced in 1951. At that time there was of course little business electronics equipment available for inspection or purchase. As is apparent in Table 1, by late 1955 relatively few machines had actually been installed for accounting applications. But 1955 saw a number of orders placed for equipment as study programs initiated in the preceding years were concluded. Earlier placement of orders might have yielded little since equipment designed for business applications is only now becoming available.

Of the 25 companies surveyed, ten exhibited vigorous interest in electronic applications in terms of their investment in committee work, school programs, attendance at society meetings and actual systems analysis and programming. Another seven companies evinced more moderate interest in the sense that they have reached no firm conclusions concerning immediate conversion to electronics. Eight companies appear to be merely watching developments; but of these, five are planning active approaches in the near future.

Again, among 25 companies, eight have designated formal policy committees to develop electronic activities though of these only five function actively. Such committees operate across department lines and include four to eight members representing the Controller's department and the cognizant operating department. They usually report directly to the company president and thus provide the necessary authority to make important policy changes to facilitate the introduction of electronic procedures. Fifteen companies devote working groups in varying strength to full-time scrutiny of specific problems. Such working groups vary in size from 1 to 25 people and report to the individual or group directly determining computer policies.

The principal responsibility for electronics in seven companies appears to lie in the Controller's department or in a Systems and Procedures division. In such cases, where a policy group has not also been formed, the ability to cross department lines in developing applications depends largely on the aggressiveness of the Controller or manager of Systems and Procedures. In eight companies the early impetus toward electronics developed in either the Research and Development departments or in one of the operating departments, although responsibility for new developments is now focused in the accounting areas. In several such instances the Research and Development department has continued an essentially separate program.

In this connection, an important policy question confronting every company is the definition of a suitable basis for acquiring electronic equipment. Generally, a full economic justification in terms of either breaking even with current clerical costs or producing even larger savings is prerequisite to placing an order for new machines in the accounting areas. Savings through electronic data processing are not always clearly anticipated or, in fact, realized on the basis of accounting applications alone. Hence,

ACCOUNTING

Refining
1. Unit cost accounting
2. Materials and supplies control

Marketing
1. Bulk sales accounting and billing
2. Credit card billing (a special problem not considered amenable to large scale EDP equipment)
3. Sales analysis

General Accounting
1. Payroll
2. Insurance and savings plans

OPERATING

Refining
1. Optimum utilization of refinery equipment in terms of given crudes and profitable yields.
2. Blending analysis (linear programming applied to gasoline, oil or crude blending.)
3. Production scheduling for barrelhouse and package goods plants.
4. Quality control.

Marketing
1. Transportation problems (linear programming applied to multi-plant, terminal and product movement).
2. Inventory control for package and bulk stock.
3. Market Research and Sales Forecasting.

Research and Engineering
1. Process design
2. Spectroscopic data reduction
3. Pilot plant data analysis
4. Refining simulation
5. Problems in maintenance and scheduling

Table 2—Ways to use the computer.

most companies seek to include engineering as well as accounting applications in justifying new equipment.

The research and engineering departments are almost invariably involved in programs leading to new installations of electronic equipment. (No less than 13 of the 25 companies interviewed for this report already employ computers of moderate capacity in research and engineering; other companies frequently make use of service bureau facilities for such problems.) There is widespread agreement in the industry today that the most important potential "payoffs" for electronic equipment lie in operating, engineering and research departments.

The Status of Equipment

The mere presentation of statistical information on equipment and orders does not in itself adequately portray the status of equipment in the field. Among the 25 companies interviewed several indicated freely, for example, that current orders for equipment were "foot in the door" measures designed to insure availability in the event of a decision that the ordered equipment was definitely necessary. In some such instances there was little evidence that any real effort was underway to reach this decision. Table 1 includes only firm orders reinforced by the assurance that systems studies and programming are already initiated for equipment ordered. Serious study has also been made the basis for including installations in the column representing future orders.

Eighteen moderate-size computer installations are now in operation among the 25 companies interviewed. Of these, 13 "scientific" machines are operated exclusively for the Research and Development and engineering departments and at least one additional machine is engaged in scientific work 80 percent of the time. The ratio of 5 accounting installations to 13 engineering installations (5 : 13) is especially interesting since within a year that ratio will have shifted around to 19 accounting to 14 engineering installations (19 : 14) of a total of 33. The latter ratio is especially significant since it includes five large-scale electronic accounting installations. While some scientific applications will undoubtedly be included on all of these machines, this data indicates the rapidity with which accounting organizations are accepting electronic techniques.

Applications of Electronics

No two companies share the same opinion as to which accounting electronic applications will assume the most importance. Depending on organization, training and disposition in the controller's department, wholesale billing, materials and supplies and finished product inventory control or still other operations are described as the key problem. Much of this depends on how effectively tabulating or manual operations are currently performing their tasks and on the relative clerical data volumes involved.

Table 2 lists the problems most frequently cited for significant volume and routine handling in both accounting and operating areas. Each of these is currently being considered for electronic data processing machines by one or more companies.

An important new area which has been demanding attention in electronic programs is operations research or management science. (This activity includes many of the applications listed above for the operating and research and development departments.) For our purposes, operations research can be defined as the science of isolating the variables in a business problem, making experimental observations to establish a weight for each variable, and predicting, through mathematical calculations, the operating results to be obtained under varying conditions.

One of the much-publicized methods of operations research is linear programming, for example: one oil company has applied linear programming to the problem of producing the maximum profit from the operation of a regional system involving a small number of refineries, almost 50 actual or projected pipe lines, and as many as ten terminals serving 200 communities.

This same technique has been applied by more than half of the companies interviewed to such problems as bettering returns through gasoline blending, improving the scheduling of plant and distribution activities and determining the best product mix for the market. From the viewpoint of data processing, operations research frequently requires machine methods, since the problems are extremely lengthy and generally involve masses of actual operating data in order to be useful. ##

About the Authors

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Tomorrow—Automatic Programming

This peek into the future of digital computers reveals great advances in the field of automatic coding.

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Remington Rand Univac
Division of Sperry Rand Corporation
Philadelphia

ANY ATTEMPT to peer, even into the near future, is sure to turn up specifications for computers and for systems strongly resembling "blue-sky" products. This phenomenon is common nowadays. Five years ago, discussion of earth satellites was confined to a few rocket scientists and a host of science-fiction fans. Today *Project Vanguard* proves that the protagonists were only a very little ahead of the times.

The design, construction, and application of electronic computers is a similar field, in that it is expanding at a tremendous rate, and the "blue-sky" specifications of today are the hardware products of tomorrow. The area of "non-hardware" computer products, more recent than the computers themselves, is growing with similar explosive violence. The non-hardware computer products are, as of now, those systems of programming and coding which supply to the computer the ability to prepare its own sets of instructions from normal human languages and enable it to store and use previously learned techniques and sequences of operations.

Over and beyond the development of the computers themselves, the growth of various automatic coding techniques has been spurred by several economic factors including the shortage of trained personnel, the need to reduce not only the costs of preparing programs and of maintaining programs but also the time required to get an installation "on the air".

At present, two fields of effort are distinguished—data-processing business and commercial problems, and mathematical and engineering computations. Since the more general operation of data-processing includes computation, it may be expected that the two fields of effort will be combined. Thus future computers and their automatic-coding systems will be constructed to handle both types of problems with equal ease.

It is wise, perhaps, to consider the current state of the art of automatic coding as a foundation from which to project the developments which can be looked for in the next few years. The existing routines vary widely in their efficiency, the classes of users for which they are designed, the formats of their pseudo-codes, and types of problems to which they may be applied.

The classes of users to be considered are two: trained programmers and laymen. Trained programmers are those who are well acquainted with a computer system, its instruction code, its logic, and the best methods for applying it. Laymen are those who know the parts of a computer system in the large: the functions of the various components and auxiliaries of their computer and their own problem subject matter. The laymen desire to make use of the computer as a tool to carry out problems in mathematics, statistics, engineering or accounting. They require that the computer deliver a good program to assist in their job. To the programmers, the computer is of greater interest than the particular problem and their primary interest lies in making the computer perform efficiently. Thus in the future, the trained programmers will become those computer experts who create the automatic routines and their libraries for the benefit of the laymen who will apply the computer to particular problems.

Since engineering problems were those first submitted to the computers and since the mathematical techniques were fairly well developed before business data-processing was tackled, the latter appeared at first as a new type of technique. It was necessary to develop program generators and techniques for handling a set of numbers constituting a business item or record before it was seen that the mathematical, scientific, and engineering problems formed a subclass of the more general data-processing routines. Thus a mathematical subroutine to compute the sine has perhaps four versions according as the quantities are expressed in fixed-point, floating-point, double-precision,

or complex floating-point notation. A data-processing routine to compare two "fields" may have many thousand versions depending upon the position of the field within an item, its length, its sign or lack of such; whether or not it is alpha-numeric and other conditions. A library then may contain a few sine routines and meet most requirements, but a library must contain a generator capable of producing any needed comparison routine. A next step forward in the future will be to include in a library a generator for sine routines. It will produce particular routines based not only on the form of the variable but also on such information as the accuracy required, the range of the input variable, etc. Instead of input-output routines handling single quantities, the data-processing routines will be applied to mathematics and the set of values at a point, the rows of a matrix, and other such natural sets. They will be manipulated as units in the same manner as a man's complete payroll record or a fractional distillation calculation. Libraries of routines will consist largely of generators capable of producing the specific routine required by the particular case.

The influence of data-processing also is manifest in the necessity of describing the data as well as the particular problem to be executed. In treating payroll, it is not enough to know that the amount of a man's deductions is included in his payroll record. The automatic programming system must be informed as to just where this information appears in his record, how many digits are used, and where the decimal point appears. Other information requires further description such as whether or not an algebraic sign is required and where it is placed. Whether the payroll record is contained in a punched-card or written as an item on magnetic tape, a complete and detailed description of the information must be made available to the programming system.

Three things are required in order to define a problem: the problem definition in English or in mathematical notation, a description of the data upon which to operate, and an automatic coding system to produce the list of actual computer instructions. In the past, two types of techniques have been used to produce these instructions. The first—called interpretation—interprets the pseudo-coded instruction and immediately carries out the required subroutine operations on the problem data. The second—called compiling—interprets the pseudo-coded instruction, selects or generates the required subroutine and then links these subroutines into a complete program for later running. Both of these methods are represented in the accompanying illustration.

Clearly, the first method is not suitable for highly repetitive problems such as make up the bulk of data-processing situations. The most sophisticated routines existing today use compiling techniques to produce a program which may contain interpretive elements within itself. The final criterion here applied to the techniques is that the final program used to run the problem shall make efficient use of all of the computer's abilities and idiosyncracies.

Since the actual program to be used to run a problem is produced by the automatic coding system, and the layman running the problem has little knowledge of the computer code, it is necessary that the automatic system substituting for the programmer also produce those other reports formerly prepared by the programmer. In addition to the running program, the automatic system must produce a description of this program and operating instructions for the program. There exists one "sort generator" which, upon submission of specifications of number and positions of keys, and item size of the data, produces not only the program required to carry out the sort but also the operating instructions. Since this generator has been in operation since 1951, it can be predicted confidently that future automatic systems will be able to prepare operating instructions for all subsequent programs.

Some compilers also produce more or less abbreviated descriptions of the programs they produce. How detailed these descriptions need to be depends upon the use to which they will be put. The trained programmer debugs a program at computer code level and will require the detailed description of the program. However, the layman is not well acquainted with computer code and certainly not prepared to debug a program at that level. He must test and check his program at the pseudo-code level and the automatic system must make provision for him to do so.

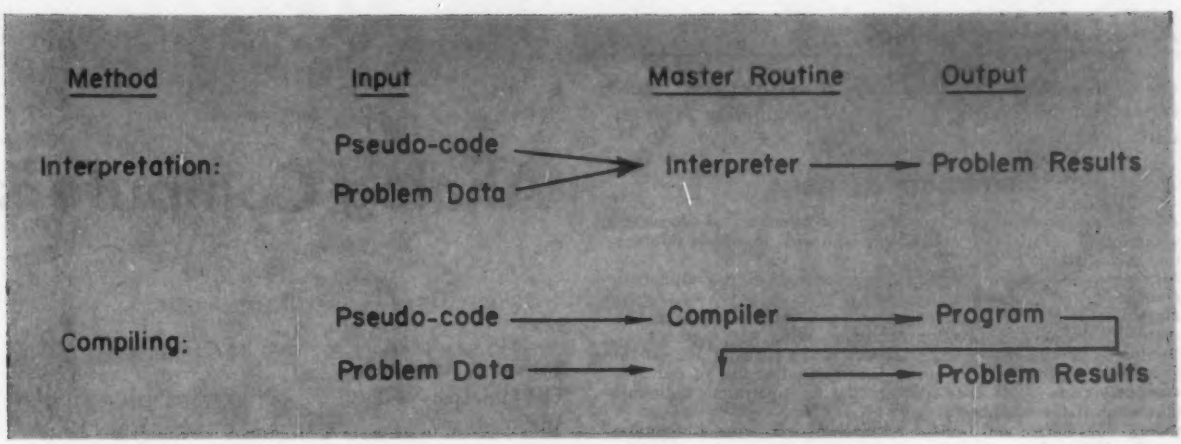
Before predicting the future abilities of the automatic coding systems, it is necessary to list those of the systems that exist today.

1. Pseudo-codes are relatively easy to learn. Problem definitions are independent of the particular computer to be used since it is the *problem* rather than the *program* which is described. The data description is independent of the problem description. Thus, new problems may be stated relating to data contained in previously described files without repeating the file description. Further, a file-format may be changed (often necessary during the preliminary stages of conversion) without invalidating the problem statement. Pseudo-codes are based on the familiar words and symbols of those who will use the computers.

2. Libraries contain three types of subroutines, static, dynamic, and generative. Static subroutines are those which remain the same for all variables and are merely transferred to a new program after suitable address modification. Dynamic subroutines are similar to the static except that certain parameters such as n in nth degree routine. The n in a routine supplies n-word items which are added at the time the subroutine is transferred from library to program. Generators do not contain the required subroutine as such but rather have the ability to produce the required subroutine when supplied with the necessary parameters. For example, if an input-output generator is supplied with a statement of the number of inputs and outputs and a description of each file, it produces all the coding necessary to handle these tapes including such details as label checking, block counts, and servo swaps.

3. The programs output by present day automatic systems are as efficient as those prepared by all but the very best programmers and are better than those produced by the average programmer. This is because the library routines are prepared by the experts and thus made available to all users.

4. Existing compiling systems include many checks on



These ways are used to produce computer instructions.

the pseudo-code written by the layman and some provisions for debugging at pseudo-code level. Some systems produce an abbreviated description of the program produced as well as operating instructions.

Future automatic coding systems obviously will be far more sophisticated. They will include all that is now operational, much that can now be specified, and more that will be learned through use and application of the present systems. The only limitation on such developments that can be foreseen is the availability of a sufficient number of personnel. Manufacturers of computing equipment are making ample funds available for these developments. The pace of the development is conditioned however by the shortage of suitable personnel and the time required to train them. However, it seems safe to predict that within the next five years automatic coding systems in operation will possess the following characteristics:

1. The system will accept pseudo-codes describing problems in customary languages.

2. The problem description will be largely independent of the data-descriptions and completely independent of the computer. It will describe a problem, not a computer program.

3. The compiled program will make highly efficient use of the computer and its auxiliaries. The compilers themselves will be speeded up and relatively little computer time will be required to produce efficient programs.

4. The system will check back on the writing of the pseudo-code and will supply missing information (always informing the user of the action taken) and will call attention to inconsistencies in problem statements. Any debugging required will be carried out at pseudo-code level assisted by service routines.

5. Outputs will include, in addition to the specified program, a description of the program, operating instructions and possibly annotated coding.

6. The system will incude service routines; a librarian to insert, delete, and correct library routines; a corrector to alter pseudo-code; an analyzer to check through a pseudo-coded problem and routines to test new subroutines and generators.

7. The system itself will be automatically prepared; it will itself be built from subroutines, some of types closely related to data-processing subroutines and some of a new and different sort. This will insure that the system will remain flexible and subject to change and improvement.

8. The routine will supply more information at the programming rather than the coding level, particularly relative to those operations closely related to the computer characteristics rather than to the conditions of the problem. The ougrowth of studies required in this area will be automatic *programming* systems in contrast to the automatic *coding* systems which exist today.

These developments are of major interest not only to the engineers designing computers but also to the users of computers. To the engineer, it means that he no longer need design a computer with a "convenient" (for human beings) instruction code. He may design a computer with an instruction code "convenient" only to the compiler and omit those operations and controls demanded by human coders. To the user, it will mean that most of his engineers and accountants will write out their own problems: that they will be trained to do so in a short period of time. The installation will require, not the services of 20 skilled programmers, but perhaps five. The funds released will be available for better system study and problem definition.

All of this is predictable and reasonable on the basis of existing routines. What is not predictable is the further functions that the programming systems will take over. Already such topics as information retrieval, learning by computers, and program planning are being investigated. How soon these projects will produce techniques which can be added into a compiling system's abilities is a matter of conjecture. Only one estimate is certain, they will develop sooner than many think. Again, the sole limitation which can be presently envisioned is the limited supply of trained personnel.

A few years ago, the user, contemplating the installation of a computer had only to collect and evaluate information concerning the available hardware. He was concerned only with "add-times," "access-time," and "pulses-per-inch." It is now clear that he must also examine the non-hardware products which accompany a computer system, since these will reduce his installation and training time and costs. They can convert his programming and coding expenditures from a recurrent and continuous cost into an investment. Undoubtedly many prospective users will

design in imagination a computer that is perhaps, a little further in the future—a "blue-sky" computer for evaluating computers.

DEFINITION OF TERMS

Address—A label such as an integer or other set of characters which identifies a register, location, or device in which information is stored.
Alpha-Numeric—Data containing decimal digits, alphabetic characters and typewriter symbols.
Block Counting—At the end of a tape and entry is made of how many blocks have been written thereon. When the tape is read, the blocks are again counted and this count checked against the previously entered block count. (Insures against loss of data.)
Computer Code—The code representing the operations built into hardware of the computer.
Debug—To isolate and remove all malfunctions from a computer or all mistakes from a routine.
Generate—To produce a needed sub-routine from parameters and skeletal coding.
Label Checking—A sub-routine to check the label written on tapes or cards, to insure that the proper ones are in the proper sequence.
Pseudo-Code—An arbitrary code, independent of the hardware of a computer, which must be translated into computer code if it is to direct the computer.
Servo Swaps—If a file consists of more than one reel of magnetic tape, two servos are used and the tape mounted thereon alternately. The program is self-actuating to read the alternate servos.
Sine Routine—The set of instructions necessary to direct the computer to carry out the computation of $y = \sin x$.
Sub-Routine—The set of instructions necessary to direct the computer to carry out a well defined mathematical or logical operation; a sub-unit of a routine. A sub-routine is often written in relative or symbolic coding even when the routine to which it belongs is not.

About the Author

GRACE MURRAY HOPPER is director for automatic programming development Remington Rand UNIVAC Division of Sperry Rand Corp. She received her B.A. degree from Vassar College in 1928, and her M.S. and Ph.D. degrees from Yale University in 1930 and 1934 respectively. She was a Vassar Faculty Fellow studying at New York University from 1941 to 1942; a Research Fellow in engineering sciences and applied physics at Harvard University from 1946 to 1949; at the Navy Department Bureau of Ordnance seminar in 1951 and 1952; and took special summer courses on digital computers at MIT in 1952, 1954, and 1956. From 1931 to 1944, Dr. Hopper was an assistant, an instructor, and an associate professor of Mathematics at Vassar College. In June, 1944, she was commissioned Lt. (J.G.) in the WAVES and spent the next two years as Mathematical Officer, U. S. Navy, Bureau of Ordnance Computer Project. She presently holds the reserve rank of Lieutenant Commander. Dr. Hopper was a Research Fellow at Harvard University from 1946 to 1949, then she joined Eckert-Mauchly Computer Corp. as senior mathematician. In 1950 she was made Senior Programmer, then in 1952 she joined Remington Rand UNIVAC as systems engineer.

Analog Computers

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THE INCREASED availability of computing devices has caused considerable interest in expanding the scope of problems which are adaptable to automatic computation. The purpose of this paper is to point out the usefulness of the analog computer in solution of natural convection problems.

The Navier-Stokes equation and the Fourier equation can be written for natural convection heat transfer from a vertical flat plate in the following manner.[1]

$$\frac{\partial\Psi}{\partial y}\cdot\frac{\partial^2\Psi}{\partial x\partial y}-\frac{\partial\Psi}{\partial x}\cdot\frac{\partial^2\Psi}{\partial y^2}=\nu\frac{\partial^3\Psi}{\partial y^3}+g\beta\Theta_a\Phi \qquad (1)$$

$$\frac{\partial\Psi}{\partial y}\frac{\partial\Phi}{\partial x}-\frac{\partial\Psi}{\partial x}\frac{\partial\Phi}{\partial y}=\alpha\frac{\partial^2\Phi}{\partial y^2} \qquad (2)$$

with boundary conditions

$$\left.\begin{aligned}\frac{\partial\Psi}{\partial y}&=0 & \frac{\partial\Psi}{\partial x}&=0 & \Phi&=1 & &\text{at } y=0\\ \frac{\partial\Psi}{\partial y}&=0 & \frac{\partial\Psi}{\partial x}&=0 & \Phi&=0 & &\text{at } y=\infty\end{aligned}\right\} \qquad (3)$$

In order to render this set of equations soluble, Pohlhausen's well known substitutions[4] are used. They are

$$\varepsilon = C\frac{y}{x^{1/4}} \qquad (4)$$

where

$$C=\sqrt[4]{\frac{g\beta\Theta_a}{4\nu^2}}$$

and

$$\eta(\varepsilon)=\Phi(x,y) \qquad (5)$$

$$Z(\varepsilon)=\frac{\Psi(x,y)}{4\nu C\sqrt[4]{x^3}} \qquad (6)$$

Introducing (4), (5) and (6) into equations (1) and (2), gives the following system of ordinary differential equations.

$$Z'''+3ZZ''-2(Z')^2+\eta=0 \qquad (7)$$

$$\eta''+3PrZ\eta'=0 \qquad (8)$$

with boundary conditions

$$\begin{aligned}Z&=0 & Z'&=0 & \eta&=1 & &\text{at } \varepsilon=0\\ Z'&=0 & Z''&=0 & \eta&=0 & &\text{at } \varepsilon=\infty\end{aligned} \qquad (9)$$

where the primes denote differentiation with respect to ε.

This system of equations would be extremely laborious to solve without the aid of a modern day computing machine. This set of equations has been programmed on a digital computer;[5] however, the equations are adaptable

Calculate Heat Transfer

Some conditions of natural convection have been calculated so that you may now use these graphs to solve your problems.

to an analog computer in a much simplier fashion, although the result is not as accurate.

The solution of the problem is one of trial-and-error in that all the initial conditions (initial conditions refer to the values of the function at $\varepsilon = 0$) must be known. Values for Z'' and η' at $\varepsilon = 0$ are assumed and if the boundary conditions (9) are satisfied, the assumed values are correct.

Figures 1 and 2 show the temperature and velocity distributions for various values of the Prandtl number, as computed by an electronic analog computer.

A schematic diagram of the wiring circuit is shown in Figure 3. The symbols used are those suggested by Korn and Korn.[2]

In order to calculate the quantity of heat which is transferred only the value of η' at $\varepsilon = 0$ is required. For if there is assumed to be a layer of stagnant fluid adjacent to the wall, one can obtain

$$Nu = -0.943\ Gr^{1/4}\ \eta'_{\varepsilon=0}$$

Values for $\eta'_{\varepsilon=0}$ and $\frac{Nu}{Gr^{1/4}}$ are given in Table 1 for various values of the Prandtl number.

TABLE 1

Pr	$\eta'_{\varepsilon=0}$	$\frac{Nu}{Gr^{1/4}}$
0.73	—0.509	0.480
2	—0.702	0.662
4	—0.871	0.821
8	—1.077	1.016
10	—1.185	1.117

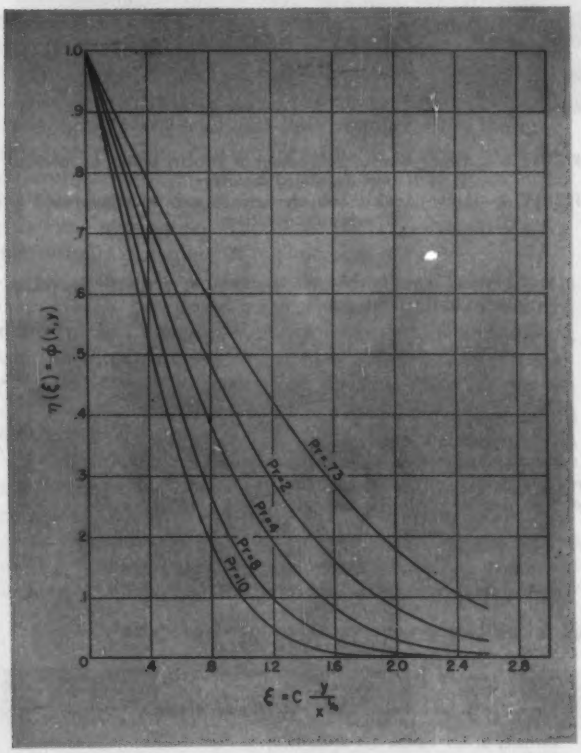

FIGURE 1—Numerical solutions of temperature profile as obtained from an analog computer.

NOMENCLATURE

$C = \sqrt[4]{\frac{g\,\beta\,\Phi_s}{4\,\nu^5}}$

Cp = heat capacity of fluid

$Gr = \frac{g\,\beta\,\Theta_s\,L^3}{\nu^2}$ (Grashoff number)

g = acceleration due to gravity
h = over-all heat transfer coefficient
k = thermal conductivity of fluid
L = height of plate

$Nu = \frac{hL}{k}$ (Nusselt number)

$Pr = \frac{Cp\mu}{k}$ (Prandtl number)

T = temperature of fluid at point
T_∞ = temperature of bulk fluid
T_P = temperature of plate

$T_s = \frac{T_P + T_\infty}{2}$

u = velocity in vertical direction
v = velocity in horizontal direction

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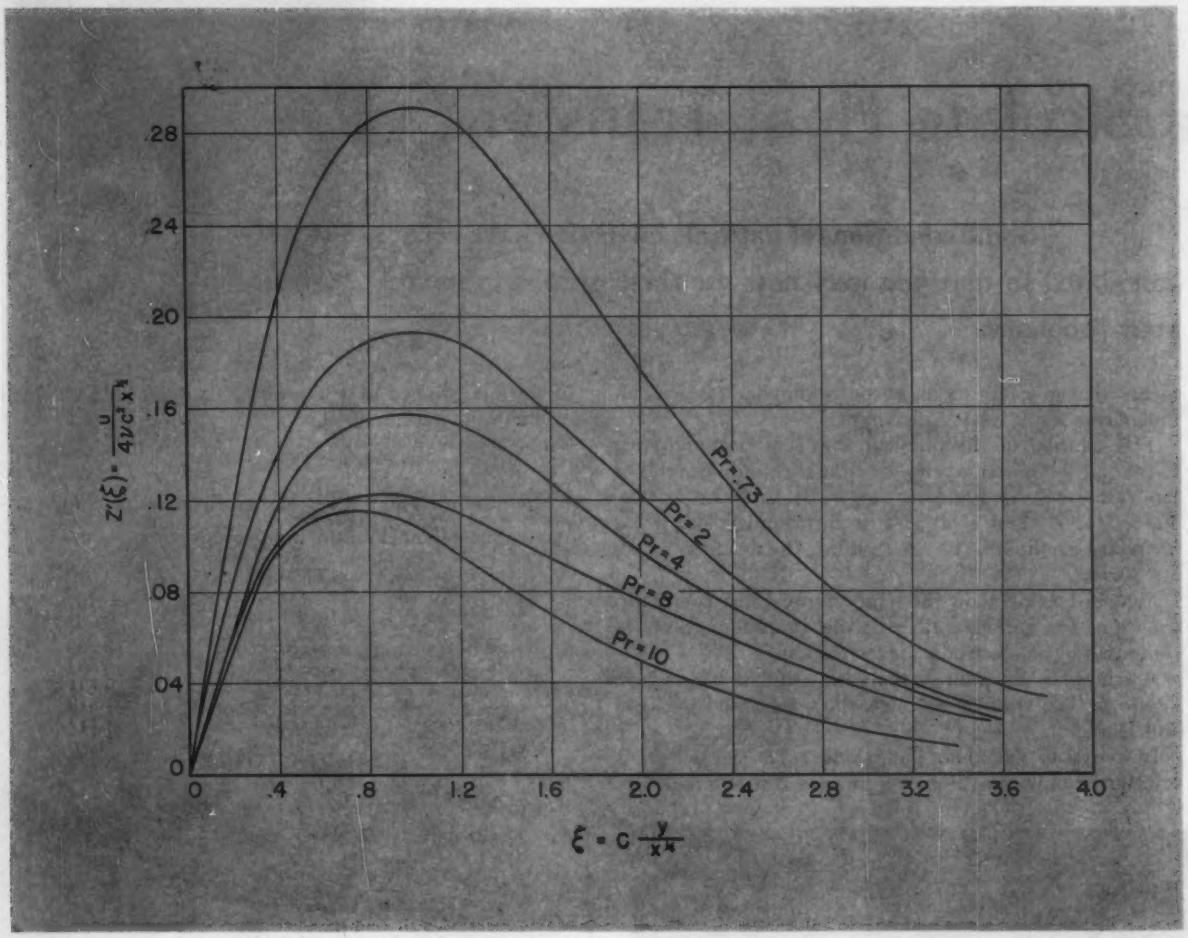

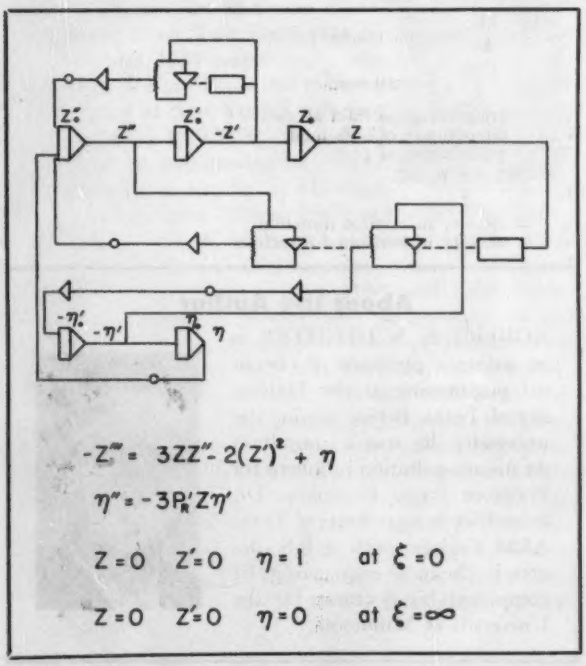

FIGURE 2—(Above) Numerical solutions of velocity profile as obtained from an analog computer.

FIGURE 3—(Left) Analog computer circuit and equations used in numerical solutions.

x, y = vertical and horizontal coordinates, respectively, of a point in the fluid

$\alpha = \frac{k}{Cp\rho}$

$\beta = \frac{\rho_\infty - \rho_a}{\rho_a (T_a - T_\infty)}$

$\eta = \Phi(x, y)$

μ = dynamic viscosity

ν = kinematic viscosity

ρ_∞ = density of fluid evaluated at T_∞

ρ_a = density of fluid evaluated at T_a

$\Phi = \frac{T - T_\infty}{T_p - T_\infty}$

Ψ = stream function defined by $-v = \frac{\partial \Psi}{\partial x}$ and $u = \frac{\partial \Psi}{\partial y}$

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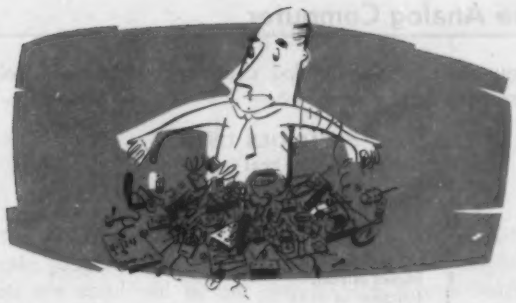


Programming the Analog Computer

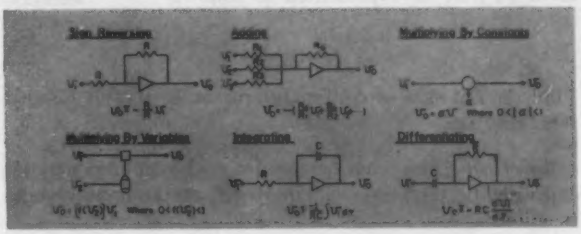
Here are ways to resolve engineering problems into mathematical equations that can be handled by the d-c analog computer.

ELECTRONIC ANALOG computers are relatively simple devices for the solution of many applied mathematical problems. Such instruments have found extremely wide applications in design, simulation, and control in various phases of engineering.

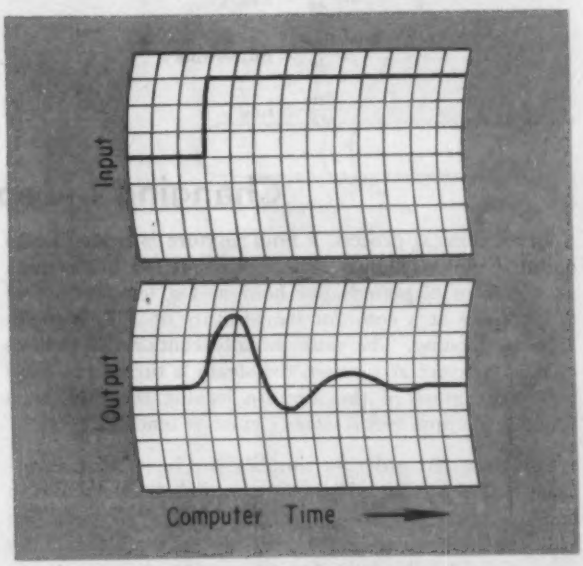
Among all types of analog computers, the d-c analog computers are comparatively cheap and easy to operate. With appropriate auxiliary elements, the analog computers can be used to solve problems involving linear and non-linear differential equations, boundary value problems, and repetitive computation of variable functions.

An inherent limitation of analog computer, however, is its inability to handle a large number of variables and operations. Commercial application will therefore be justified by the nature and flexibility of problems, accuracy required, volume of data, and convenience of operations.

The d-c analog computer is composed of a number of d-c amplifiers and feedback networks. With the addition of time motor, potentiometer or servo multiplier, a d-c analog computer can generally perform many useful mathematical operations. After a network is set up to represent a problem, the boundary values or initial conditions of the problem are fed to the computer as feed voltages. The circuit is closed then and its output voltage varies under the prescribed conditions of the operational machine equation. The computer may be stopped at any time by opening the circuit.



The output voltage of the computer is recorded continuously as the graphical solution of the problem. The change of output voltage may be recorded with respect to the operating time of a computer as shown in Figure 1. Then the output voltage will represent the dependent variable of a problem, and the computer time the independent variable. If a problem involves more than two dependent variables, two of the variables may be recorded by a continuous drum recorder or x-y recorder to yield a regular rectangular graphical plot. The computer solution usually provides 0.5 to 5 percent accuracy.



The principal work in connection with the analog computer is the programming work. This includes the mathematical analysis of the problem, transformation of the mathematical expression into an operational equation, and circuit analysis. The physical setup of analog circuits and operation of the computer is more or less mechanical in a sense.

The following problems are presented to demonstrate the general principles involved in programming an analog computer. There are a few methods for setting up machine equations for the analog computer. The examples represent some typical engineering problems and will show the relation of the mathematical equations to the

It's easy to resolve engineering problems into computer setups using these simple symbols

D.C. Amplifier | Potentiometer | Resister | Condensor | Servo-Motor

After you decide the best mathematical form which represents the problem, the d-c analog computer can take over and do the calculations.

components of the analog computer which will solve these equations.

SYMBOLS USED

A	Surface area for heat transfer
B	Slab thickness
b	Conversion factor
C	Electrical capacitance
C_p	Specific heat capacity
D	Diameter
F	Moles of feed
f	Friction of drag
G	Flow rate
g	Gravitational constant
v_h	Horizontal velocity
K	Vapor-liquid equilibrium constant
k	Thermal conductivity
L	Moles of liquid
l	Reactor length
m	Positive integer
N	Number of theoretical trays
n	Moles of component present
P	Pressure
p	Perimeter
R	Electrical resistance
r	Reaction rate constant
s	Distance from free end
S	Function of s
T	Temperature of heating medium
t	Temperature of system
U	Over-all heat transfer coefficient
V	Moles of vapor
V_r	Volume of reactor
v	Vertical velocity
W	Weight of system
x	Mole fraction in liquid phase
y	Mole fraction in vapor phase
z	Percent conversion
α	(Refer to Discussion)
β	(Refer to Discussion)
Θ	Function of θ
θ	Time of process change
π	3.14
ρ	Density
τ	Operating time of computer

Linear First-Order Differential Equation

The reaction of A to form B, which in turn reacts to form C, may be represented as follows:

$$A \xrightarrow{r_1} B \xrightarrow{r_2} C$$

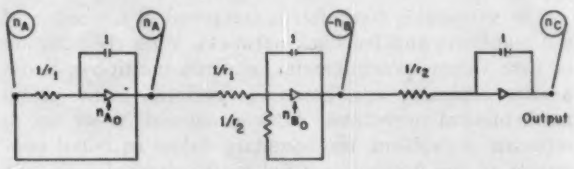
Find the changes in concentrations of A, B, and C with reaction time.

Solution—The reaction rate for such reactions may be expressed by the following equations, assuming no reverse reactions:

$$-\frac{dn_A}{d\theta} = r_1 n_A$$

$$\frac{dn_B}{d\theta} = r_1 n_A - r_2 n_B$$

$$\frac{dn_C}{d\theta} = r_2 n_B$$



An electrical network representing these equations is shown. If the initial concentrations n_{Ao} and n_{Bo} are fed to the computer as voltage equivalents, the circuit will yield n_A, n_B, and n_C in volts as functions of the computer time. If the reaction time and the computer time are expressed in the same unit of seconds, the recorder voltage outputs of n_A, n_B, and n_C will then represent the corresponding concentration changes versus reaction time.

Changing Independent Variables

In a chemical process, a fluid mixture is heated in an agitated tank as shown. The mixture is fed to the tank at a rate of G pounds per hour and a temperature of t_o F. Steam at a constant temperature of T F. is available for heating. The tank initially contains W pounds of fluid mixture at t_o when the steam is turned on. Find the temperature of the mixture leaving the tank as a function of time before steady state is reached.

Solution—In order to simplify the heat balance, assume that the fluid mixture in the tank is at a uniform temperature equal to that of the mixture leaving the tank. A heat balance for the unsteady state will be represented by the following equation:

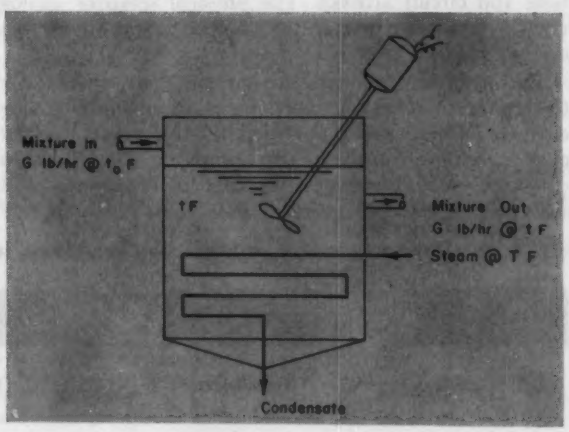
$$UA(T - t) = GC_p(t - t_o) + WC_p\frac{dt}{d\theta}$$

The independent variable Θ of the above equation is the time of unsteady heating and is usually expressed in hours. The equation can be processed through a computer by changing Θ into the computer time τ in seconds by the following relationship:

$$\tau = 3600\,\Theta$$

Hence $$\frac{dt}{d\tau} = \frac{UAT - GC_pt_o}{3600\,WC_p} - \frac{UA + GC_p}{3600\,WC_p}t$$

Since U, A, T, G, C_p, t_o, and W are constants, the above



equation can be greatly simplified by writing in the following form.

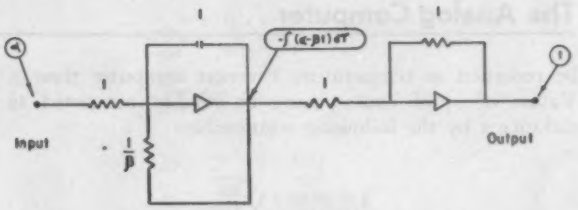
$$\frac{dt}{d\tau} = \alpha - \beta t$$

where

$$\alpha = \frac{UAT - GC_p t_o}{3600\, WC_p}$$

$$\beta = \frac{UA + GC_p}{3600\, WC_p}$$

The resulting equation is an ordinary differential equation of the first order. It can be solved readily by the computer setup shown here. The network involves one summation and an integration as indicated by the operational equation. The machine output voltage will represent the temperature t of the fluid mixture leaving the tank. The temperature is recorded as a function of machine time τ.



The electronic computation of this problem is rather simple, judging from the fact that only two d-c amplifier units are employed in the circuit. The formal mathematical solution of the equation, however, is much more involved and may be written as follows.

$$t = \frac{\frac{UA}{GC_p}(T - t_o)}{\frac{UA}{GC_p} + 1}\left\{1 - \exp\left[-\left(\frac{UA}{GC_p} + 1\right)\left(\frac{G\theta}{W}\right)\right]\right\} + t_o$$

Linear Second-Order Differential Equation

A metal rod of circular cross section is placed in a stream of hot gas having a constant temperature T. Assume that (1) the temperature of gas surrounding the rod is uniform and (2) the temperature gradient in the radial direction in the rod is negligible. Calculate the temperature distribution within the rod along the axis as a result of simultaneous convection and conduction.

Solution—A heat balance for an element of length ds of the rod may be set up as the following.

Heat in at s by conduction $= -kA\frac{dt}{ds}$

Heat in to the whole section ds by convection around the periphery $= U(T - t)\,pds$

Heat out at s + ds by conduction

$$= kA\left[-\frac{dt}{ds} + \frac{d}{ds}\left(\frac{dt}{ds}\right)ds\right]$$

Equating the total heat input to output, we have

$$-kA\frac{dt}{ds} + U(T - t)\,pds = kA\left[-\frac{dt}{ds} + \frac{d^2t}{ds^2}\,ds\right]$$

This can be simplified to be

$$\frac{d^2t}{ds^2} = \frac{Up}{kA}(T - t)$$

To apply electronic computation, the temperature t in the rod will again be represented by a voltage. The distance s will be transformed into computer time by letting

$$s = \alpha\tau$$

where α is a constant.

Substituting $\alpha\tau$ for s, the equation becomes

$$\frac{1}{\alpha^2}\frac{d^2t}{d\tau^2} = \frac{Up}{kA}(T - t)$$

In order to simplify the resistance elements in the computer circuit, the value of α may be chosen so that

$$\alpha = \sqrt{\frac{kA}{Up}}$$

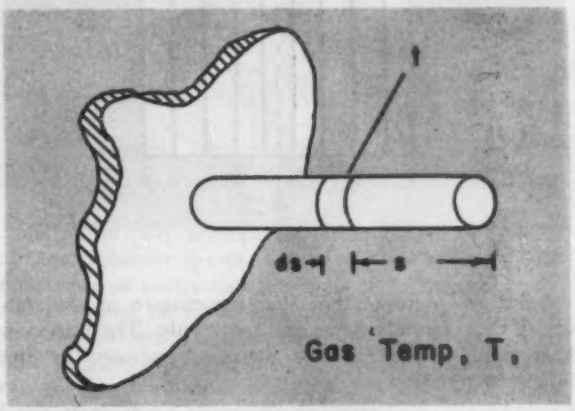
The equation then reduces to

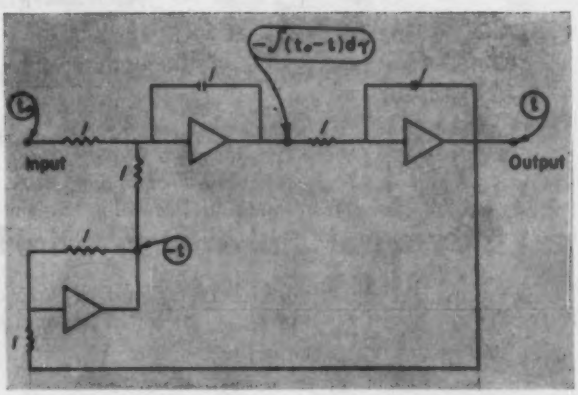
$$\frac{d^2t}{d\tau^2} = T - t$$

where the boundary condition is $t = T$ at $s = 0$ and all values of τ. Written in an integral form, the equation becomes

$$t = \int_o^\tau \int_o^\tau (T - t)\,d\tau\,d\tau$$

This problem represents a linear differential equation of the second order. The computer setup is prepared according to operational equation shown above. The boundary condition is satisfied by feeding a voltage corresponding to T into the computer. The solution will



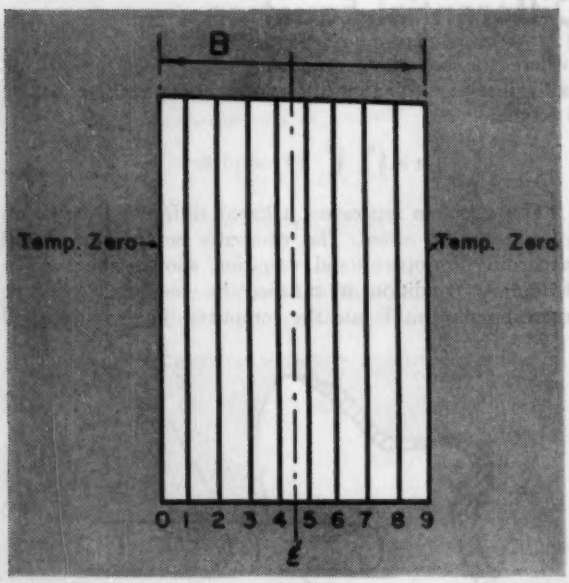


be recorded as temperature t versus computer time τ. Values of τ, of course, may be readily converted to distance s by the following relationship:

$$s = a\tau = \tau\sqrt{\frac{kA}{Up}}$$

Partial Differential Equation

Calculate the temperature distribution in a slab of finite thickness B. The slab is initially at a uniform temperature t' and its faces are kept at temperature zero.



Solution—Assume that the temperature in the slab varies with distance from the faces only. The unsteady heat transfer problem can then be expressed by the following equation:

$$\frac{\partial t}{\partial \theta} = \frac{k}{C_p\rho}\,\frac{\partial^2 t}{\partial s^2} \quad (0 < s < B, \theta > 0)$$

The boundary conditions are, for $t = t(s, \theta)$,

$$t(s, o) = t' \qquad (o<s<B)$$
$$t(o, \theta) = 0 \qquad (\theta>o)$$
$$t(B, \theta) = 0$$

To separate the variables, assume that

$$t = S(s)\,\Theta(\theta)$$

where $S(s)$ and $\Theta(\theta)$ are functions of s and θ alone. Differentiating the above equation according to the heat transfer equation, we obtain

$$S\Theta' = \frac{k}{C_p\rho}S''\Theta$$

Rearrange the above equation

$$\frac{C_p\rho}{k}\,\frac{\Theta'}{\Theta} = \frac{S''}{S} = a$$

where a is a constant. It follows therefore

$$\frac{d\Theta}{d\theta} = \frac{ak}{C_p\rho}\,\Theta$$

Let

$$\tau = 3600\,\Theta, \quad \beta = \frac{1}{3600}\,\frac{ak}{C_p\rho}$$

Thus,

$$\frac{d\Theta}{d\tau} = \beta\Theta$$

$$\frac{d^2S}{ds^2} = a$$

Where the boundary conditions become

$$\Theta(o) = t'$$
$$S(o) = 0$$
$$S(B) = 0$$

The differential equation of Θ is a function of time and consequently can be solved by a single feedback integration. The equation of S, however, is a function of distance s. The independent variable s should then be transformed into computer time by letting

$$\tau = \frac{b}{B}s$$

where b is a conversion factor in seconds. This provision permits the choice of any value for b corresponding to the slab thickness B. Take for example b = 10 seconds. At 5 seconds of machine time, therefore, the computer output will indicate a function corresponding to s = B/2, the center plane of the slab.

With the change of independent variable, the differential equation of S is transformed into the following form:

$$\frac{b^2}{B^2}\,\frac{d^2S}{d\tau^2} = aS$$

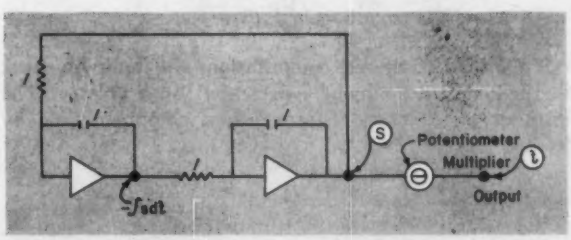
For the sake of simplicity in the computer setup, choose the value of b so that

$$\frac{aB^2}{b^2} = 1$$

The above equation becomes

$$\frac{d^2S}{d\tau^2} = S$$

Here is the computer setup for this equation.



Since the temperature in the slab is determined by two independent variables, i.e., distance s and time θ, a two-dimensional solution may be obtained by correlating temperature against one of the two variables and using the other one as a parameter. According to the derivation, therefore, the computer output of Θ may be multiplied by a constant value of S with the aid of a potentiometer multiplier. The product of $S\Theta$ will indicate the temperature at a certain point in the slab as a function of time. Since both faces of the slab are kept at tem-

perature zero in this problem, a symmetrical temperature distribution in the slab is anticipated. If the slab thickness B is divided into nine even parts, as shown in the figure, only four temperatures at s_1, s_2, s_3, and s_4 will be necessary to express the temperature distribution. A complete set of computer solution would then include four continuous temperature curves of $t(s_1, \theta)$, $t(s_2, \theta)$, $t(s_3, \theta)$ and $t(s_4, \theta)$.

On the other hand, the variable computer output of S may be multiplied by a constant value of Θ in order to generate continuous functions of temperature in the slab in terms of distance at certain instant θ.

The method of finite difference may be used as an alternate solution. The slab is first divided as before into a number of even parts along its thickness. The heat transfer rate may then be approximated in the following.

$$\frac{dt}{ds} \cong \frac{\Delta t}{\Delta s} = \frac{t_{n+1} - t_n}{\Delta s}$$

$$\frac{d^2t}{ds^2} \cong \frac{\Delta^2 t}{\Delta s^2}$$

$$= \frac{1}{\Delta s}\left(\frac{t_{n+1} - t_n}{\Delta s} - \frac{t_n - t_{n-1}}{\Delta s}\right)$$

$$= \frac{1}{\Delta s^2}(t_{n+1} - 2t_n + t_{n-1})$$

where the subscripts n + 1, n, n—1 are referred to the number of cross section in the suab.

Since $\frac{\partial t}{\partial \theta} = \frac{k}{C_p \rho}\frac{\partial^2 t}{\partial s^2}$

We have the following approximation:

$$\frac{\partial t}{\partial \theta} = \frac{k}{C_p \rho}\frac{1}{\Delta s^2}(t_{n+1} - 2t_n + t_{n-1})$$

The increment Δs may be chosen such that

$$\frac{k}{C_p \rho} = \Delta s^2$$

Hence $\frac{\partial t}{\partial \theta} = t_{n+1} - 2t_n + t_{n-1}$

The above equation expresses the change of temperature at cross section n in terms of the temperatures at cross sections n—1, n, and n+1. Solution of this equation is simplified in consideration of the symmetrical temperature distribution in the slab. For example, when n=9, we have for all values of θ the following relationships.

$$t_0 = t_9$$
$$t_1 = t_8$$
$$t_2 = t_7$$
$$t_3 = t_6$$
$$t_4 = t_5$$

According to the Schmidt approximation, therefore,

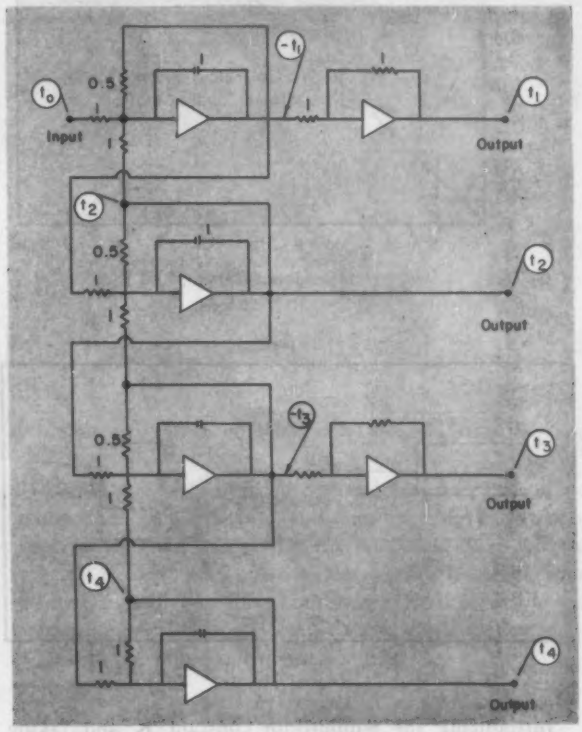
$$\frac{dt_1}{d\theta} = t_0 - 2t_1 + t_2$$

$$\frac{dt_2}{d\theta} = t_1 - 2t_2 + t_3$$

$$\frac{dt_3}{d\theta} = t_2 - 2t_3 + t_4$$

$$\frac{dt_4}{d\theta} = t_3 - 2t_4 + t_5 = t_3 - t_4$$

These equations can be solved simultaneously by analog computer very readily with the network shown here.



The initial slab temperature t' is satisfied by feeding it to the computer circuit. Values of t_1, t_2, t_3 and t_4 will be obtained as continuous functions of machine time.

The method of finite difference has been developed for numerical analysis of unsteady heat transfer in finite slabs. Its accuracy depends on the number of cross sections in the slab taken into consideration. Application of this method on electronic computer has been found very satisfactory.

The partial differential equation of heat transfer as shown above can be formally solved by means of Fourier series. Its solution is:

$$t(s, \theta) = \frac{4t'}{\pi}\sum_{1}^{\infty}\frac{1}{2m-1}\exp\left[\frac{-(2m-1)^2\pi^2 k\theta}{C_p \rho B^2}\right]\sin\frac{(2m-1)\pi S}{B}$$

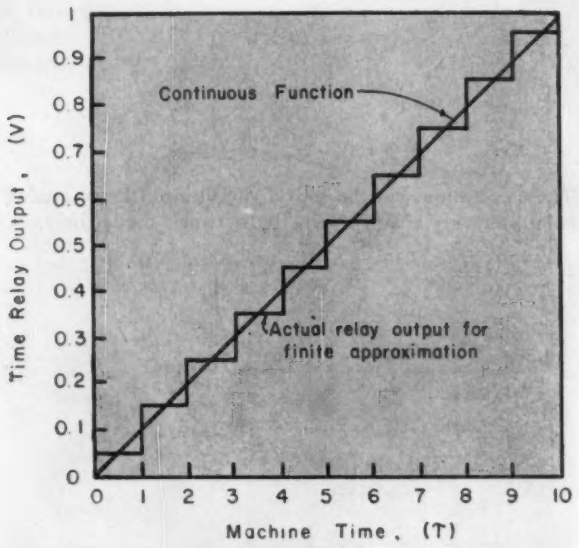
Function Generation by Finite Approximation

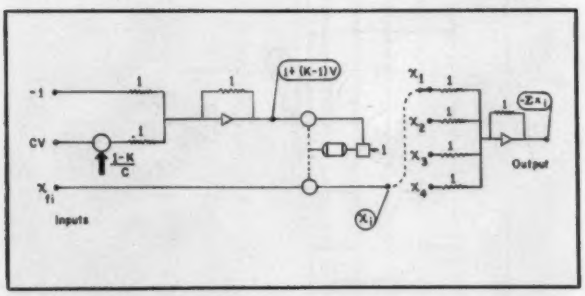
Find the ratio of vapor to liquid which exists after flashing a petroleum fraction.

Solution—The flash vaporization of a hydrocarbon mixture is usually expressed by the following equations of material balance:

$$F = L + V$$
$$Fx_{fi} = Lx_i + Vy_i$$

The Analog Computer . . .





Introducing the equilibrium constant K and taking $F = 1$, these equations may be combined to give the following:

$$x_i = \frac{x_{fi}}{1 + (K_i - 1)V}$$

where $K_i = y_i/x_i$ and V becomes moles of vapor per mole of feed vaporized. Since the summation of mole fraction x of all components in the mixture is 1, we have then

$$\Sigma x_i = \frac{x_{fi}}{1 + (K_i - 1)V} = 1$$

In flash vaporization calculations, it is usually required to determine L and V at predetermined flash temperature and pressure. In the equations, therefore, K_i's are constants at constant temperature and pressure, and V is the independent variable. As has been illustrated in the previous problems, V should be transformed into machine time scale in order to solve the equations by electronic computer. However, to generate the function x_i according to the equation, it is also necessary to feed values of V as voltages into the circuit.

This requirement may be approximated through the additional use of a time relay device. Choose for instance a machine time of 10 seconds to represent the entire range of V (i.e., $0<V<1$). A time relay may then be arranged in accordance with the relation shown in the accompanying graph. The relay output V will change from 0 to 0.5, 1.5, 2.5, etc., in volt every second and will be fed into the circuit shown in the diagram.

This circuit will then generate a function of x_i according to the equation. A summing network will indicate the machine time required for $\Sigma x_i = 1$. If the machine time is 5.64 seconds, for example, V would be 0.564 mole per mole feed at a relay setting of 10 seconds.

A function generating circuit, such as is shown, will be required for each of the components in the feed. With such a circuit setup, it is merely necessary to change the voltage input x_{fi} and equilibrium constant K_i in routine calculations for different feed composition and operating conditions.

A plate-to-plate calculation may be made by applying this method to a multi-component fractionating column. Take the calculation of minimum number of theoretical plates under total reflux for example. We have the following conventional equations:

$$\Sigma x_N = \Sigma \frac{y_N}{K_N} = 1$$

$$y_{N+1} = x_N$$

For computer calculation, the equilibrium constants K may be expressed as functions of temperature alone for different components. The temperature function may be generated by a time motor which is operated in conjunction with the computer. The plate temperature will then be determined by the computer in terms of machine time required to satisfy $\Sigma x_i = 1$. Consecutive plate-to-plate calculation may be carried out by proper network made according to both equations.

The difficulties in applying electronic computer to problems of such nature are the requirement of known functions of equilibrium constant K for all components in the system and a large number of network elements.

Function Generation in a Closed Circuit

It is required to separate an oil-water mixture by means of a standard oil separator shown here. The overflowing level of oil is s feet above the lower end of the oil retention wall. Calculate the minimum length of separation section of the separator.

Solution—The minimum dimension of the separation section may be determined by first estimating the time required for an oil globule to arise from *s* feet beneath the level. To analyze the flow path of an oil globule, its velocity is resolved into vertical component v and horizontal component v_h. The horizontal velocity of an oil globule is constant throughout the separation section. It is equal to the total volume flow rate divided by the

cross-sectional area of the separator. The vertical velocity is nevertheless a variable and is dependent upon a force balance which is derived in the following.

Assume an average diameter D for the oil globules.

Accelerational force of the oil globule $= \frac{\pi D^3}{6} \rho_o \frac{dv}{d\theta}$

Buoyancy of the globule $= \frac{\pi D^3}{6} (\rho_w - \rho_o) g$

Drag force against the upflowing globule $=$

$$\frac{f\left(\frac{\pi D^2}{4}\right)\rho_w v^2}{2}$$

The force balance may then be set up as below:

$$\frac{\pi D^3}{6} \rho_o \frac{dv}{d\theta} = \frac{\pi D^3}{6} (\rho_w - \rho_o) g - \frac{f \pi D^2 \rho_w v^2}{8}$$

$$\frac{dv}{d\theta} = \frac{\rho_w - \rho_o}{\rho_o} g - \frac{3f \rho_w v^2}{4D\rho_o}$$

Or

$$\frac{dv}{d\tau} = \alpha - \beta v^2$$

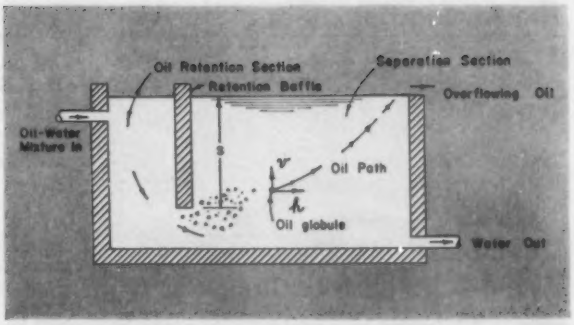
if $\theta = \tau$, $\alpha = \frac{\rho_w - \rho_o}{\rho_o} g$ and $\beta = \frac{3f \rho_w v^2}{4D\rho_o}$. Both α and β are constants provided that a constant value of friction factor f is used.

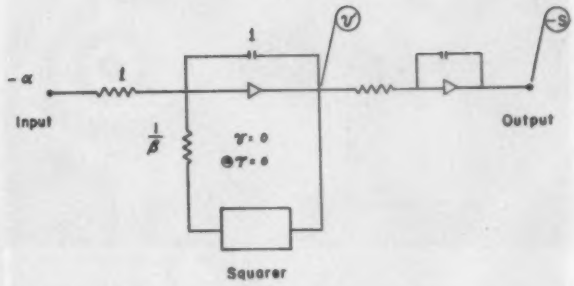
The vertical velocity v may be integrated with respect to time to give the vertical traverse distance of an oil globule within a given time. Since the total vertical traverse distance s and the function of vertical velocity are known, the above equation is employed to determine the time required for an oil globule to arise to the overflowing surface. An electronic circuit may be set up according to the following equation:

$$S = \int v dt$$

$$= \iint (\alpha - \beta v^2) d\tau d\tau$$

The computer setup as shown here consists of a typical





function-generating element in a closed circuit for the variable v.

The circuit output is the vertical traverse path of an oil globule as a function of retention time in the separation section. The minimum retention time for the vertical traverse path equal to the given value s may then be determined. The minimum longitudinal length of the separation section equals simply to the horizontal velocity V_h times the minimum retention time.

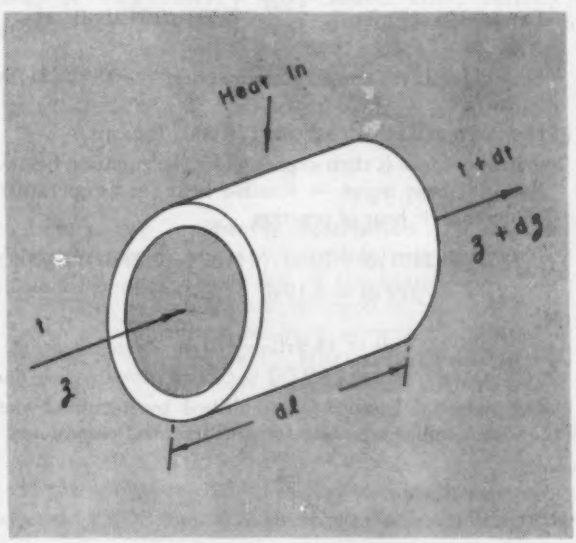
Simultaneous Equations

Vapor of sulfuryl chloride at 200 F and 1.2 atm. is fed to a 1½-inch reactor tube at a rate of 418 pounds per hour. The reaction tube is heated at a rate of 5000 Btu/(hr.)(sq. ft.) based on the internal area. The reactor tube has an inside diameter of 1.334 inches. At elevated temperature the SO_2Cl_2 decomposes by a first-order reaction to form SO_2 and Cl_2. It is desired to decompose 98 percent of the SO_2Cl_2 fed. The pressure drop in the reactor and the reverse reaction may be neglected. Calculate the length of reactor tube required.

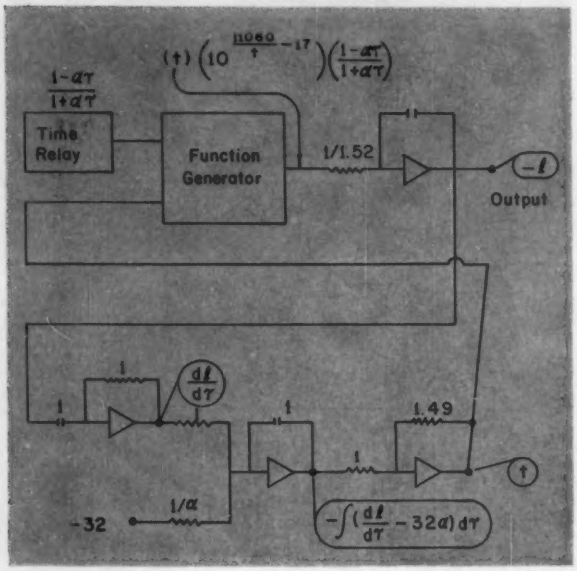
The rate constant r for the uncatalyzed reaction may be represented by the following expression.

$$r = (6.427)\ (10^{15}) e^{-59630/t}\ sec^{-1}.$$

where the temperature t is in °K.



Solution—The decomposition of sulfuryl chloride is an endothermic reaction. Since there is an excess of external heat supply to the reactor, the reaction temperature will change along the entire length of the reactor tube. While the reaction rate is a function of



temperature, the conversion of sulfuryl chloride per unit length of the reactor will not be uniform. Calculation of the reactor length will consequently be made by heat and material balance over a differential section of the reactor.

Assume that in a differential section dl of the reactor there occurs a conversion of dz mol/mol feed and the temperature increases by dt. A heat balance may be established as follows.

Since M.W. of SO_2Cl_2 = 134.91

Feed rate = 418/(134.91)(3600)

= 0.39 gr. mol/sec.

Internal heating surface = 0.3491 sq. ft./ft.

Average heat of reaction = 10,000 cal/mol SO_2Cl_2

Average specific heat = 21 cal/(mol)(°K)

Consequently, for a differential section of the reactor,

External heat input $= \frac{5000}{3600}(252)(0.3491)\,dl$ Btu/sec

Sensible heat for temperature increase = (0.39)(21)dt Btu/sec

Heat of reaction = (0.39 dz)(10,000) Btu/sec

The heat balance is then expressed by the equation below.

External heat input = sensible heat for temperature increase + heat of reaction

$$\frac{5000}{3600}(252)(0.3491)\,dl = (0.39)(21)\,dt + (0.39\,dz)(10{,}000)$$

$$122\,dl = 8.19\,dt + 3900\,dz$$

Or,

$$dt = 14.9\,dl - 476\,dz$$

$$= 14.9\,(dl - 32\,dz)$$

The material balance is established by means of the following familiar equation for a differential reactor.

$$V_r = \frac{dn}{d\theta} = F\,dz$$

where the reaction rate $dn/d\theta$ is in mol SO_2Cl_2 decomposed per second per liter. The reactor has a volume of 28.3 liters per linear foot. We can therefore solve for V_r/F as below.

$$\frac{V_r}{F} = \frac{\pi}{4}(1.334^2)\frac{1}{144}(28.3)(dl)\frac{1}{0.39} = 0.705\,dl$$

An expression for $dn/d\theta$ may be found in terms of partial pressure, which in turn can be expressed by the percentage of decomposition.

$$\frac{dn}{d\theta} = rn$$

$$= rP/Rt$$

$$= r\,(1.2)\,\frac{1-z}{1+z}\,\frac{1}{Rt}$$

$$= (6.427)(10^{15})\,e^{-50610/Rt}(1.2)\,\frac{1-z}{1+z}\,\frac{1}{Rt}$$

Combine the expressions of V_r/F and $dn/d\theta$ now.

$$0.705\,dl = \frac{dz}{(6.427)(10^{15})\,e^{-50610/Rt}(1.2)\,\frac{1-z}{1+z}\,\frac{1}{Rt}}$$

Upon simplifying, we have

$$dl = (1.52\,t)\,10^{\frac{11060}{t} - 17}\,\frac{1-z}{1+z}\,dz$$

In order to process through the computer, choose the reactor length l and reaction temperature t as the dependent variables and percent conversion z independent variable. Assume that:

$$z = \alpha\tau$$

Where α is a constant. We have then

$$l = (1.52\,\alpha)\int t\,10^{\frac{11060}{T} - 17}\,\frac{1-\alpha\tau}{1+\alpha\tau}\,d\tau$$

$$t = (14.9)\int\left(\frac{dl}{d\tau} - 32\,\alpha\right)d\tau$$

where the initial conditions are l = 0 and t = 366.3° K at $\tau = 0$.

The simultaneous equations may be solved with the combination of two circuit systems as shown in the block diagram. The circuit output of l will indicate readily the required reactor length at a computer time corresponding to a conversion of 98 percent. # #

About the Author

H. H. YANG is an assistant professor of chemical engineering at Lamar State College of Technology at Beaumont, Texas. Before coming to the U. S. in 1952 to take up graduate studies in chemical engineering, Dr. Yang was assistant process engineer for Chinese Petroleum Corporation's Kaohsiung refinery on Formosa. He is a graduate of China's National Chung Chen University, holds a master's degree from the University of Notre Dame and completed his Ph.D. at the University of Michigan.

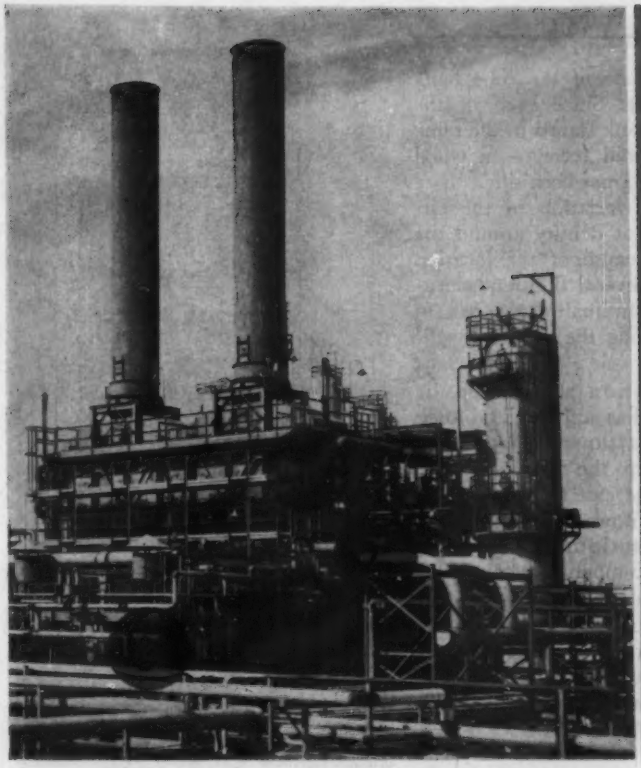


TABLE 1
Design Data for 18,000 BPSD Reformer Charge Heater

Radiant Section:	
No. of tube banks	8
No. of tubes	112
Size of tubes	6" x 5"
Surface, sq. ft.	5,725
No. of burners	80
Type of burners	Nat. Airoil Oil & Gas
Length x Width x Height	42' x 42' x 33'
Firebox volume, c.f.	58,000
Convection Section:	
Bare surface, sq. ft.	4,320
Extended surface, sq. ft.	11,200
TOTAL	15,520
Design:	
Heat release, BTU/H	167,500,000
Air preheat, BTU/H	9,200,000
TOTAL	176,700,000
Radiant section duty, BTU/H	103,000,000
Rate, BTU/H/sq. ft.	18,000
Convection section duty, BTU/H	44,700,000
Rate, BTU/H/sq. ft.	2,880
Total steam generation, lbs./H	58,500
Steam to air preheaters, lbs./H	12,000
Net steam production, lbs./H.	46,500
Net efficiency, %	82.7
Excess air, %	25
Stack temp., °F	665°

This 18,000 bspd reformer has these design features:

1 CONVECTION SECTION has conventional horizontal tubes. 450 psig steam is generated by the exit gases and is partially used for preheating burner air.

2 OIL INLET HEADERS are elevated and easily accessible. For services requiring frequent internal inspection and maintenance, the heater may be elevated.

3 HORIZONTALLY MOUNTED BURNERS supplied with pre-heated air are located at several elevations midway between and on both sides of the vertical tube banks.

New Design for Process Heaters

This simple principle of double-firing of vertically suspended tube banks gives more efficient use of radiant tube surface.

Ralph Morrow
Sun Oil Company
Philadelphia

THIS ENTIRELY new process heater design now offers the refiner a more efficient utilization of costly radiant section tube surface. The principle involved is the double-firing of vertically-suspended tube banks.

The first heaters of this type were designed and built for use with a reformer unit at Sun Oil Company's Marcus Hook refinery. Four such heaters were placed in service in November, 1953, and, except during two normal shutdowns for equipment inspection, have operated continuously to date.

Subsequently, three larger heaters of substantially the same design were built for use with a second reformer, also at Sun's Marcus Hook refinery. Placed in service in August, 1955, these latter three heaters are giving equally satisfactory performance.

Heater Description—The process stream is heated entirely in the radiant section of the heater, where the tubes are arranged in banks or coils disposed in a vertical position (see Figure 1). Horizontally-mounted burners supplied with preheated air are located at several elevations midway between and on both sides of these vertical banks.

The direction of firing is thus in a vertical plane parallel to and on both

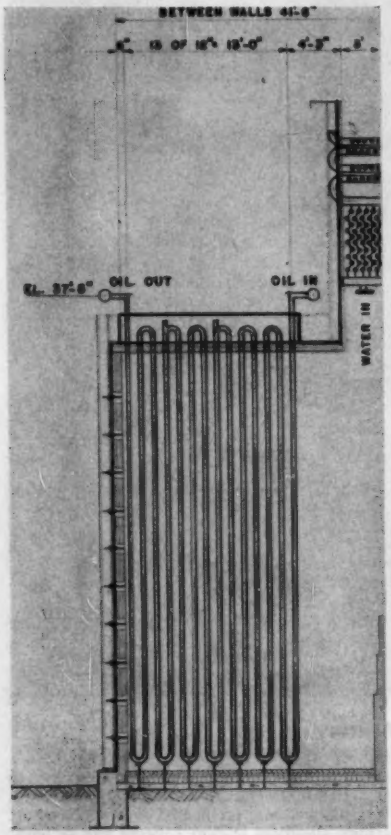


FIGURE 1a—Sectional elevation through furnace showing vertical tube banks and horizontal convection section.

sides of the plane of the tube bank (See Figure 2). Since each of the tubes in each bank stands in the same vertical plane and receives an equal amount of heat from both sides, there is a minimum variation in the circumferential heat density around the tubes. Also, because of the location of burners at several different elevations, the longitudinal variation in heat density along the tubes is negligible.

The convection section of the heater, which has a horizontal tube arrangement, is situated on top of and lengthwise to the radiant section. The path of the exit flue gases from the firebox is upwards through the convection section, discharging through two top-mounted steel stacks. This convection section is designed to generate 450 pounds per square inch gage steam, part of which is diverted to supply the burner air preheat, and the balance of which is used for other process requirements. Actual design data are given in Table 1.

Heat Flux Pattern—An analysis of the principle of double-firing the radiant section tubes is given in Figure 3. Shown is a graphical determination of the heat flux pattern around the individual tubes in a conventional wall tube heater design as compared to the pattern around double-fired tubes (1, 2).

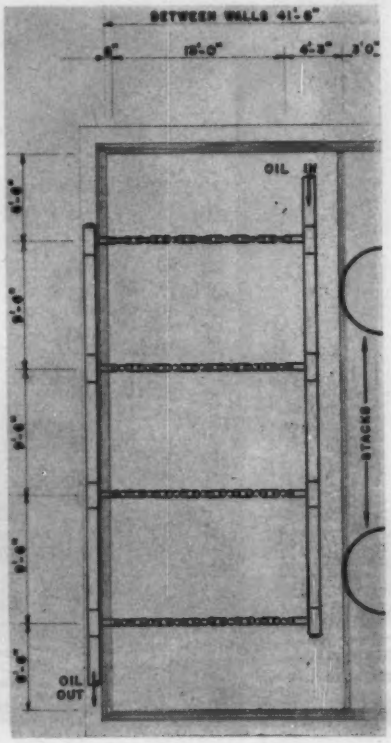


FIGURE 1b—Sectional plan of the furnace showing the inlet and outlet headers as well as the location of the stacks.

It will be noted in Table 2 that for a conventional wall tube design with tube spacing at two diameters, the ratio of the maximum heat flux on the face of the tubes to the average heat flux around the tubes is approximately 1.8:1. For double-fired tubes at the same spacing, this ratio of maximum heat flux to average heat flux is reduced to approximately 1.2:1.

Heating Effectiveness—Of greater importance, however, is the fact that the total effectiveness of the tube banks in a wall tube design is found to be only 0.882 (i.e., 88.2 percent of a black body). Double-firing of the vertical tube banks increases their effectiveness by almost 50 percent to a value of 1.314.

From this concept, it follows that for a given maximum heat flux on the face of the tubes, only two-thirds the total tube surface must be employed in this new design as is required for a wall tube design. Another way of stating this is that two tubes fired on

TABLE 2

Effectiveness of Single Row Tube Banks

	I CONVENTIONAL WALL TUBES Radiating Plane on one side, refractory on other side; tube spacing 2 diameters			II DOUBLE-FIRED VERTICAL TUBES Radiating Planes on both sides; tube spacing at 2 diameters		
POINT NO.	Direct	Rerad.	Total	Direct From Plane 1	Direct From Plane 2	Total
1	1.000	0	1.000	1.000	0	1.000
2	0.918	0	0.918	0.918	0	0.918
3	0.676	0.027	0.703	0.676	0.080	0.756
4	0.336	0.115	0.451	0.336	0.336	0.672
5	0.080	0.232	0.312	0.080	0.676	0.756
6	0	0.315	0.315	0	0.918	0.918
7	0	0.342	0.342	0	1.000	1.000
8	0	0.315	0.315	0	0.918	0.918
9	0.080	0.232	0.312	0.080	0.676	0.756
10	0.336	0.115	0.451	0.336	0.336	0.672
11	0.676	0.027	0.703	0.676	0.080	0.756
12	0.918	0	0.918	0.918	0	0.918
Total	5.020	1.720	6.740	5.020	5.020	10.040
Average	0.418	0.143	0.562	0.418	0.418	0.837

Maximum flux / Average flux	1.000 / 0.562	=	1.779
Direct Radiation	$\frac{0.418\pi D}{2D}$	=	0.657
Reradiation	$\frac{0.143\pi D}{2D}$	=	0.225
Total effectiveness		=	0.882

Maximum flux / Average flux	1.000 / 0.837	=	1.195
Direct Radiation from Plane 1	$\frac{0.418\pi D}{2D}$	=	0.657
Direct Radiation from Plane 2	$\frac{0.418\pi D}{2D}$	=	0.657
Total effectiveness		=	1.314

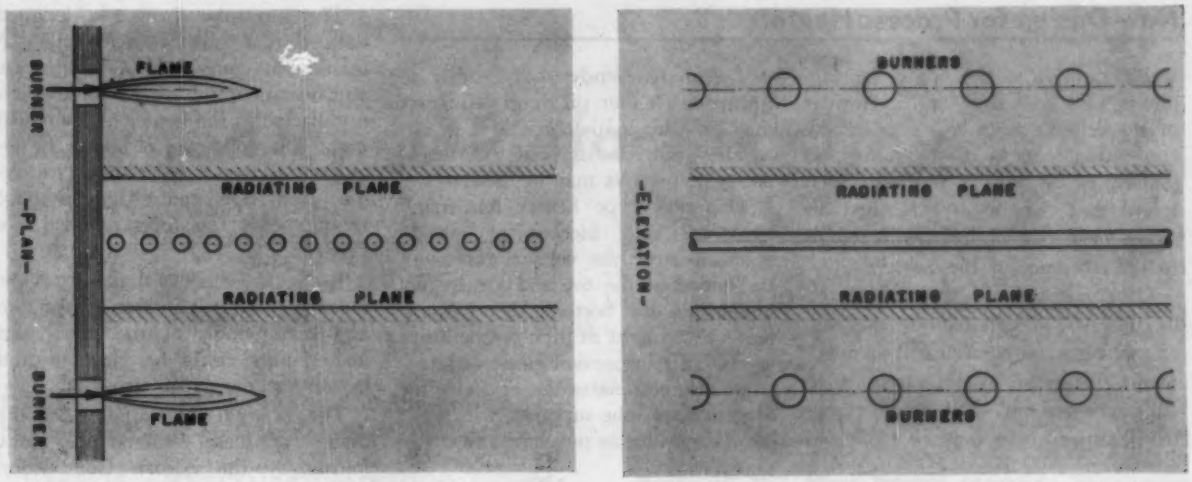


FIGURE 2—DOUBLE FIRING OF VERTICAL TUBES.
Plan (left) and Elevation (right) showing arrangement of tubes and burners so that each of the tubes in a vertical bank is exposed equally to the radiating plans.

both sides will give the same radiant absorption as three tubes fired only on one side at the same rate.

Less Pressure Drop—Further, it is apparent that for a given pressure drop and the same maximum heat flux, the tubewall temperature will be lower in the double-fired vertical tube arrangement, than in a wall tube design because the mass velocity will be greater while the tube travel is less. This is of value in obtaining maximum heat transfer within a range of safe-operating conditions.

Actual Data—Evidence that the foregoing analysis is justified has been obtained in actual plant operation. Table 3 gives a comparison between design and survey data for the first group of four heaters built at Marcus Hook. Examination of the data will show that the radiant extraction obtained is well within the range to be expected when account is taken of the rate of firing, fuel heating value, excess air, etc.

Table 4 gives the results of a tubewall temperature survey made on the second reformer Charge Heater. Shown is the method of calculating the "clean" tubewall temperature of 1007 F. based upon a maximum flux rate of 17,400 BTU/H/sq. ft. Actual measured temperatures ranged from 1010 to 1072 F. It is interesting to note that subsequent internal inspection of the tubes showed them to be scaled, with the pattern of scaling identifiable with the higher tubewall temperatures.

Process Advantages—These heaters have demonstrated their flexibility in operation to the extent that

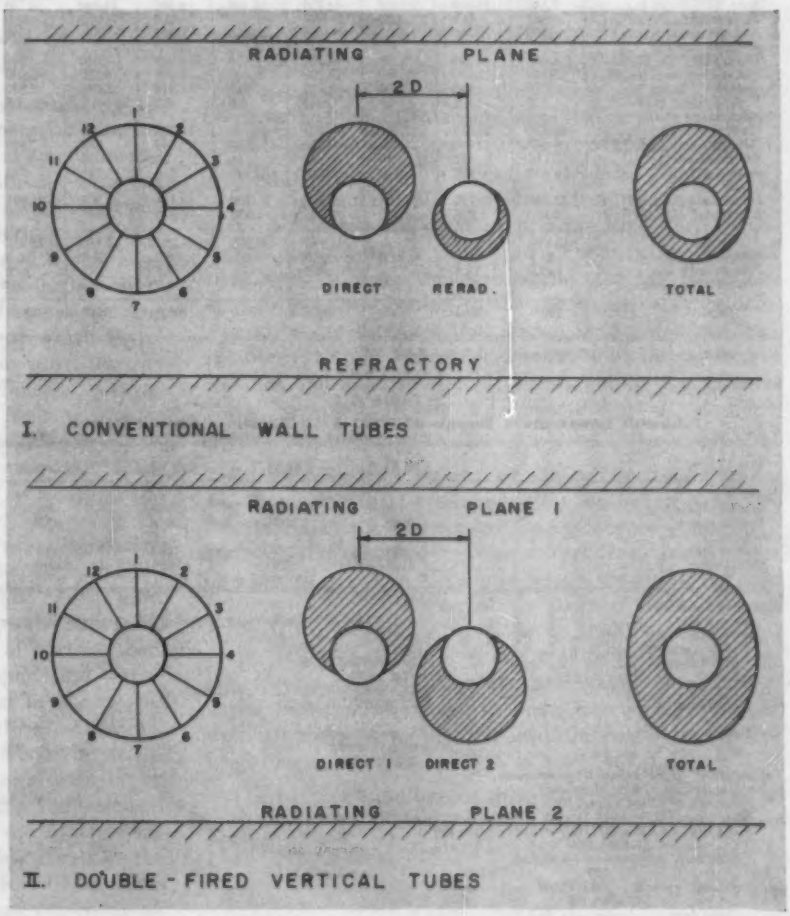


FIGURE 3—HEAT FLUX PATTERN.
Comparison of heat flux patterns between conventional wall tubes (upper) and double fired vertical tubes (lower). Note the uniformity of heat flux in the latter.

when radiant section duty requirements have been low, large quantities of steam have been generated in the convection sections by increasing the percent excess air. It has also been found that the use of preheated air to the burners is optional with regard to the efficiency of the heaters.

Other process advantages offered by this new design include the ease of making series-parallel coil arrangements. With the proper attention to coil arrangement, any shape time-temperature curve may be easily obtained.

The design lends itself readily to firing with either oil or gas. Burners may be individually controlled, or automatic instrumentation of whole banks of burners may be used.

This new type heater has many structural and mechanical advantages. Because the vertical tubes are suspended at the top and are merely guided at the bottom, they remain perfectly straight at high temperature levels. This suspension-guide arrangement also eliminates the necessity for intermediate tube supports, which are often expensive to purchase and costly to maintain.

TABLE 3
Design and Survey Data for Double-Fired Vertical Tube Heaters

DESCRIPTION	H-1		H-2		H-3		H-4	
	Design	Actual	Design	Actual	Design	Actual†	Design	Actual
Radiant Section:								
Charge, lbs./H	156,200	186,500	156,200	186,500	156,200	186,500	156,200	186,500
Temp. in, F	800	803	760	803	810	863	870	901
Temp. out, F	950	950	970	936	970	940	970	947
Duty, MM BTU/H	20.000	29.076	29.700	28.026	24.100	10.277	15.400	11.855
Rate, BTU/H/sq. ft.	7,180	10,440	14,960	14,120	15,160	6,460	13,940	10,730
Percent extraction	69.7	61.4	61.7	58.9	82.3	55.9	62.8	52.6
Exit gas temp., F	1090	1390	1395	1520	1405	1290	1355	1505
Convection Section:								
Duty, MM BTU/H	3.960	10.359	9.220	10.764	7.170	4.274	4.410	5.621
Steam generation, lbs./H	5,190	12,700	12,080	13,200	9,400	5,200	5,780	6,900
Rate, BTU/H/sq. ft.	740	1,925	2,400	2,790	2,540	1,515	2,080	2,650
U, BTU/H/sq. ft./F	2.5	4.4	4.8	4.8	5.0	3.7	4.2	4.5
Combustion:								
Fuel gas, SCFH	40,200	33,615	67,100	33,570	54,100	13,320	34,250	16,030
Net heating value, BTU/cf.	680	1360	680	1360	680	1360	680	1360
Percent excess air	15	17	15	21	15	57	15	47
Stack temp., F	600	609	740	722	740	615	740	743
Overall:								
Heat release, MM BTU/H	27.300	45.716	45.700	45.655	36.800	18.115	23.300	21.801
Air preheat, MM BTU/H	1.390	1.628	2.320	2.038	1.870	0.276	1.180	0.733
Total	28.690	47.344	48.020	47.693	38.670	18.391	24.480	22.534
Percent efficiency	82.5	82.7	80.0	80.5	80.0	78.8	80.0	76.8
Percent stack loss	13.5	13.3	17.3	16.5	17.2	18.2	17.2	20.2
Percent setting loss	4.0	4.0*	2.7	3.0*	2.8	3.0*	2.8	3.0*
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* Assumed. † Upset reactor. Only half-firing.

TABLE 4
Tubewall Temperature Survey—18,000 B/SD Reformer Charge Heater

LOCATION	Coil No. 1	Coil No. 2	Coil No. 3	Coil No. 4
North Side:				
Middle tube	941	978	960	892
Outlet tube	1055	1025	1038	1038
South Side:				
Middle tube	934	973	923	863
Outlet tube	1072	1038	1010	1016

Operating Conditions:
- Charge rate: 303,000 lbs/H Naphtha Vapor, including 9.8 wt. percent hydrogen
- Inlet temperature: 640 F.
- Outlet temperature: 910 F.
- Calculated duty: 83,000,000 BTU/H
- Surface: 5725 sq. ft.
- Average rate: 14,500 BTU/H/sq. ft.
- Maximum rate (i.e. 1.2:1): 17,400 BTU/H/sq. ft.

Coil Description: 8 pass arrangement; 6" x 5" tubes; 2¼ Cr 1 Mo

Calculation of "clean" tubewall temperature:

For film coefficient, from McAdams[3]

Formula $h = 0.0144 \times \text{Spec. Ht.} \times G^{0.8}/D^{0.2}$

Where Spec. Ht. = 1.013, G = 277,000 lbs./H/sq. ft. and D = 5"/12

$h = 0.0144 \times 1.013 \times (277{,}000)^{0.8}/(0.417)^{0.2} = 390$

$$\text{Film drop} = \frac{17{,}400 \times 6''/5''}{390} = 53.5$$

For metal, where k = 200 BTU/H/sq. ft./inch/F.

$$\text{Metal drop} = \frac{17{,}400 \times 0.5}{200} = 43.5$$

"Clean" tubewall temperature = Oil temperature + film drop + metal drop
= 910 + 53.5 + 43.5
= 1007 F.

The top tube sheets are designed with slotted holes which makes it feasible to completely shop-fabricate and heat-treat the coils prior to their installation in the heater as assembled units. The coils can, of course, be removed in the same manner for replacement and repair. Ground space requirements for tube removal are very small.

It should be noted that for services requiring frequent internal inspection and maintenance of the tubes, this heater may easily be elevated and bottom header boxes provided.

The original development of the design of these heaters was done jointly by the Alcorn Combustion Company and Sun Oil Company's Engineering division. Permission of both companies was obtained to publish the design and operating data contained in this article.

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About the Author

RALPH MORROW is an assistant process engineer in the process design section, Engineering division at Sun Oil Co. He was born in Philadelphia in 1919 and graduated from Drexel Institute of Technology in that city in 1942 with a B.S. degree in chemical engineering. Shortly after graduation, Morrow joined Foster-Wheeler Corp., and stayed there until he joined the Navy in 1944. Morrow returned to Foster-Wheeler in 1947 as a project engineer. He joined Sun Oil in 1951 and since then has worked in the Engineering division, collaborating with other process engineers on the design of new refining units and the re-design of existing ones.

A proven method . . .

How to Design Perforated Trays

- New method
- New correlations
- Detailed example calculations

I. Leibson, R. E. Kelley and L. A. Bullington
Humble Oil & Refining Company, Baytown, Texas

HERE IS A SYSTEMATIC METHOD for perforated tray design. Literature data are used to develop new correlations for dry tray pressure drop in terms of percentage perforation area and the ratio of plate thickness to hole diameter. Equations for the calculation of static liquid seal height from the modified Francis weir formula for rectangular weirs and the calculation of pressure drop for liquid flow through the downcomer clearance are described. A detailed example of the application of the design method in specifying perforated trays to replace bubble cap trays at the top of an atmospheric pipe still tower is given at the end of the article.

Consider the Design Limits—In bubble cap tray design, flooding, excessive liquid entrainment and blowing action constitute the upper limits of operation. Pulsation, dumping and excessive hydraulic gradient represent lower vapor rate limits of tray operation. Maximum and minimum vapor and liquid loadings also govern the limits of stable tray operation in perforated tray design. In this case, the lower limit corresponds to a minimum vapor rate (for a given static liquid seal height, i.e., the depth of vapor-free liquid on the tray) at which liquid weepage through the perforations causes unstable tray operation and loss of mass transfer efficiency. Consequently, in designing a perforated tray for a particular fractionation service, it is necessary to check the conditions of maximum and minimum liquid and vapor loadings to insure that the final design falls well within the region of stable tray operation.

In selecting the maximum design rates, sufficient allowance should be made to insure adequate capacity for maximum sustained loading conditions; i.e., in most cases maximum design rates will be greater than the liquid and vapor loadings representative of normal operating conditions. At the maximum liquid and vapor loadings, the height of vapor-free liquid in the downcomer should not exceed 50 percent of the tray spacing.

As in the design of bubble cap trays, it may be necessary to increase the tray spacing or tower diameter in order to satisfy this requirement. If the limitation is largely due to a high liquid rate, the use of two-pass rather than single-pass trays will probably result in the minimum tower diameter. The method for the selection of tower diameter for bubble cap towers presented by Perry's Handbook[8] is recommended for use in the design of perforated tray fractionation towers.

Basis of This New Design Method—The design method presented in this article is based on the determination of the perforation area necessary to insure a height of vapor-free liquid in the downcomer not to exceed 50 percent of the tray spacing at the maximum liquid and vapor loads. This assumes that the average aeration factor of the frothy liquid in the downcomer is 0.5. Aeration factor is defined as the ratio of the density of the aerated liquid to that of the unaerated liquid. A value of 0.5 has been very widely used in the literature in design calculations for bubble cap trays.

Experimental studies to explore downcomer flow patterns and downcomer frothy liquid densities as a function of vapor and liquid rates and also system physical properties (using hydrocarbon systems) are very badly needed.

After the perforation area is calculated on the basis of the maximum vapor and liquid loadings, it is necessary to calculate the dry tray pressure drop corresponding to the minimum vapor rate. To avoid weepage of tray liquid through the perforations, the dry tray pressure drop corresponding to the minimum vapor velocity should be greater than that shown in the weepage correlation (given in Figure 3). The static liquid seal height used as the abscissa should correspond to the greatest static liquid seal height to be encountered at the minimum vapor rate.

Calculating the height of Liquid in Downcomer, L_D—In developing an expression for the height of vapor-free liquid in the downcomer, L_D, of Figure 1, one may consider the downcomer from tray "a" to tray "b" as one side of a simple U-tube in which the balancing side is composed of the sum of the liquid pressure drop through the clearance area between the downcomer and plate "b," P_{dc}; the static liquid seal height on an average section of "b," $L_{s_{avg}}$; the hydrostatic head of the vapor between trays, h_v; the dry tray vapor pressure drop through tray "a," P_D; and the static liquid seal height on an average section of tray "a," $L_{s_{avg}}$.

The balance equation for these hydrodynamic forces is:

$$\left[H + L_{s_{avg}} - L_D\right]\frac{\rho_V}{\rho_L} + L_D = P_{dc} + L_{s_{avg}} + \left(h_v\right)\frac{\rho_V}{\rho_L} + P_D + L_{s_{avg}} \quad (1)$$

Solving Equation (1) for L_D, the height of vapor-free liquid in the downcomer:

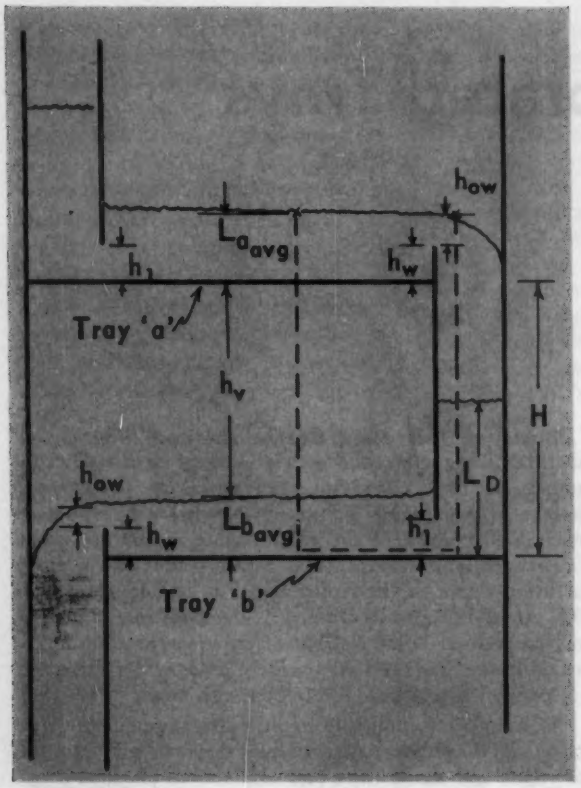

FIGURE 1—Schematic flow diagram.

$$L_D = \left[P_{dc} + L_{b_{avg}} + \left(h_v\right)\frac{\rho_V}{\rho_L} + P_D + L_{s_{avg}}\right]\frac{L}{\rho_L - \rho_V} - \left[H + L_{s_{avg}}\right]\frac{V}{\rho_L - \rho_V} \quad (2)$$

Equation (2) may be further simplified for the usual case of towers operating at moderate pressures by assuming that the vapor density is negligible compared to the density of the liquid. A word of caution is important here! In light ends towers, this assumption cannot usually be made and it is necessary to take the effect of vapor density into account in design calculations. Nevertheless, in the usual case at moderate pressures:

$$L_D = P_{dc} + L_{b_{avg}} + P_D + L_{s_{avg}} \quad (3)$$

$$\text{or} \quad L_D = P_{dc} + L_{b_{avg}} + P_T \quad (4)$$

where P_T is the total vapor pressure drop across tray "a" expressed in inches of hot vapor-free liquid.

Calculating, the Static Liquid Seal Height; $L_{b_{avg}}$— Two cases must be considered in determining the average static liquid seal height. For designs in which no inlet weir is provided, the average static liquid seal height is given by the following equation:

$$L_{b_{avg}} = h_{ow} + f\,h_w \quad (5)$$

where h_{ow} = head over the weir for tray "b," inches of hot vapor-free liquid
h_w = height of the weir above the plate for tray "b," inches
f = aeration factor (assumed to be unity for design purposes)

Equation (5) assumes a negligible hydraulic gradient for perforated trays which has been shown to be the case by most investigators.[1,7] However, if an inlet weir is provided, it is necessary to calculate the static liquid seal height corresponding to the inlet weir length and height. If the value of the static liquid seal height obtained in this manner is greater than that given by Equation (5) then it should be used in determining the height of vapor-free liquid in the downcomer, L_D.

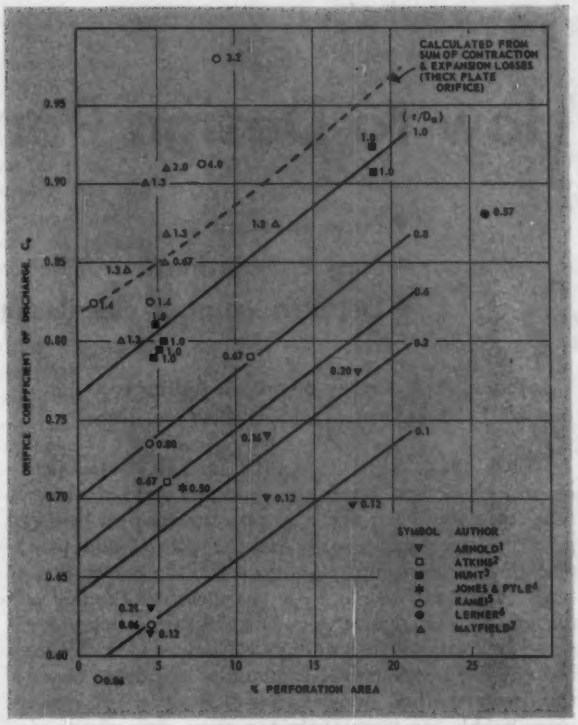

FIGURE 2—C_o for dry tray pressure drop calculation. (3/16-inch diameter holes.)

The head of vapor-free liquid over the weir may be calculated from the Francis formula for rectangular weirs:

$$h_{ow} = \left(\frac{Q}{2.98\,L_w}\right)^{2/3} \quad (6)$$

where Q = gallons per minute of hot vapor-free liquid
L_w = weir length, inches

The aeration factor, f, is defined as the specific gravity of the aerated liquid referred to the density of hot, vapor-free liquid. Mayfield's[7] aeration data for the air-water system indicate that the aeration factor is a function of vapor rate, liquid rate and liquid depth. Studies of bubble formation from vertical rectangular slots[10] and horizontal orifices[9] submerged in quiescent water have shown that bubble formation occurs by one of two distinct mechanisms of formation, the "deep" and the "shallow" with the choice of the prevailing mechanism dependent upon the magnitude of the liquid depth above the orifice (or slot). For aerated liquid depths less than some critical value, the "shallow" mechanism prevails and the air entering the liquid forms a channel jetting through the liquid with no formation of discrete bubbles.

Bubble formation by the "deep" mechanism occurs for values of submergence greater than the critical or maximum attainable channel length. Under these conditions discrete bubble formation occurs with bubbles breaking liquid in the downcomer:

away from the end of the channel. The channel constitutes a tail through which air is fed to the bubble until buoyancy and induced liquid circulation cause detachment. Mayfield's aeration data for the air-water system indicate that the critical channel length for this system is approximately two inches of vapor-free liquid. Thus, one might expect the interfacial contact area between the vapor and liquid phases (at constant vapor and liquid rates) and also the mass transfer efficiency to decrease markedly for liquid seal depths less than two inches. For this reason, a minimum liquid seal of two inches is recommended for design purposes.

At liquid depths greater than two inches, the aeration factor decreases (i.e., liquid becomes more aerated) with increases in air rate. On the other hand, aeration factor increases with increases in liquid rate. At liquid depths less than two inches, the aeration factor increases (i.e., liquid becomes less aerated) as air rate increases.

No data concerning aeration factor for hydrocarbon systems could be found in the literature. Theoretical considerations indicate that the variation of aeration factor with respect to vapor rate, liquid rate, and liquid depth may be similar to that for the air-water system. However, the effect of such system physical properties as vapor-liquid interfacial tension, liquid density and liquid viscosity on the aeration factor must be evaluated before a generalized correlation for aeration factor can be developed. For design purposes it is conservative to assume an aeration factor of unity and this is recommended as standard procedure.

Because of its large contribution to total tray pressure drop, liquid seal on the tray should normally not exceed four inches. Therefore, the *maximum* outlet weir height above the plate should be determined as follows:

$$h_w = 4.0 - h_{ow} \qquad (7)$$

Outlet weir height will normally be greater than 1½ inches but less than three inches.

How to Calculate the Liquid Pressure Drop Between Clearance of Downcomer and Plate (P_{dc})—The clearance h_1, between the downcomer and the plate below, should be based on taking a pressure drop of less than one inch of hot liquid. For a design in which no inlet weir is provided, the pressure drop for liquid flow through the clearance of the downcomer and plate may be calculated from the conventional submerged weir formula:

$$P_{dc} = 0.057 \left(\frac{Q}{A_1}\right)^2 \qquad (8)$$

where P_{dc} = pressure drop in inches of hot liquid
Q = gallons per minute of hot liquid
A_1 = clearance area between the downcomer and tray, square inches.

The recommended minimum clearance is 1½ inches. The increase in the clearance for larger liquid loads may be in ½-inch increments up to a maximum of four inches. If the downcomer to tray clearance is greater than the static liquid seal height on the tray at the minimum liquid rate, an inlet weir of suitable height should be provided to insure that the downcomer is actually sealed in the plate liquid in order to avoid vapor blowback through the downcomer. If an inlet weir is provided, the following modification of Equation (8) is recommended.

$$P_{dc} = 0.068 \left(\frac{Q}{A_1}\right)^2 \qquad (9)$$

where A_1 = clearance area between either the downcomer and tray or between the downcomer and inlet weir, whichever is the smaller, square inches.

The greater value of the constant shown in Equation (9) as compared to that in Equation (8) takes into account a loss of 0.75 velocity heads due to the partial reversal of liquid flow which occurs for a design in which an inlet weir is provided.

Now, the Total Vapor Pressure Drop (P_T)—The total vapor pressure drop (P_T) is the sum of the dry tray pressure drop (P_D) and the static liquid seal height ($L_{s_{avg}}$). The dry tray pressure drop may be calculated using the simple orifice equation with the appropriate value of C_o, the coefficient of discharge, determined as a function of percent perforation area and the ratio of tray thickness to orifice diameter from Figure 2. Percent perforation area is defined as the ratio of the effective perforation area to that portion of the tower cross section (beneath the tray) which is available for vapor flow.

$$P_D = 0.186 \left(\frac{u_o}{C_o}\right)^2 \left(\frac{\rho_V}{\rho_L}\right) \qquad (10)$$

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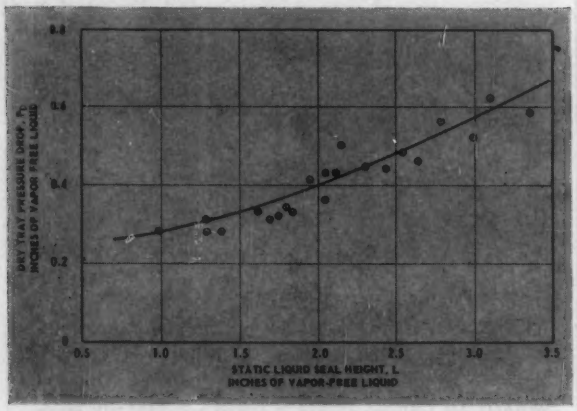

FIGURE 3—Weepage correlation. Data calculated to aeration factor of unity. (3/16-inch diameter holes.)[7]

where P_D = dry tray pressure drop, inches hot liquid
u_o = linear vapor velocity through the perforations at flowing conditions, feet/second
C_o = coefficient of discharge
ρ_V = vapor density at flowing conditions, pounds/cubic foot
ρ_L = vapor-free liquid density at flowing conditions, pounds/cubic foot

Figure 2 is based on values of the percent perforation area, the ratio of the tray thickness to hole diameter and the orifice coefficient of discharge (shown in Table 1) calculated from the available dry tray pressure drop data in the literature.[1, 2, 3, 4, 5, 6, 7] These values should be used only where the pressure drop is very small compared to the absolute pressure.

The lack of agreement concerning the orifice coefficient of discharge reported from dry tray pressure drop studies by previous investigators can be explained in terms of the effect of the percent perforation area and the ratio of tray thickness to orifice diameter. When analyzed for these effects, the literature data, although meager, indicate good agreement among the various sources.

TABLE 1
Literature Data Concerning Coefficient of Discharge for Dry Tray Pressure Drop Calculation

Inches D_o	Percent Perforation Area	t/D_o	C_o	Column Diam., Ft.	Author
0.250	4.5	0.12	0.615	1.25	Arnold, et al.[1]
0.139	4.5	0.21	0.630	1.25	"
0.235	11.9	0.12	0.700	1.25	"
0.177	12.0	0.16	0.740	1.25	"
0.249	17.4	0.12	0.695	1.25	"
0.144	17.8	0.20	0.780	1.25	"
0.188	5.7	0.67	0.710	0.5x2.5 Rect	Atkins[2]
0.188	11.0	0.67	0.790	0.5x1.3 Rect.	"
0.125	4.9	1.0	0.811	0.5	Hunt, et al.[3]
0.250	5.4	1.0	0.801	0.5	"
0.375	5.1	1.0	0.794	0.5	"
0.500	4.9	1.0	0.790	0.5	"
0.125	18.8	1.0	0.923	0.5	"
0.250	19.0	1.0	0.908	0.5	"
0.500	21.5	1.0	0.890	0.5	"
0.125	6.7	0.5	0.705	1.5	Jones and Pyle[4]
0.197	1.0	0.06	0.585	0.43	Kamei, et al.[5]
0.197	4.6	0.06	0.620	0.43	"
0.197	4.6	0.80	0.735	0.43	"
0.197	4.6	1.4	0.825	0.43	"
0.197	1.0	1.4	0.825	0.43	"
0.197	9.0	3.2	0.98	0.43	"
0.197	8.0	4.0	0.913	0.43	"
0.218	26.0	0.57	0.88	0.5	Lerner, et al.[6]
0.188	5.7	0.67	0.850	0.5	Mayfield, et al.[7]
0.188	3.2	1.3	0.846	0.5	"
0.188	5.7	1.3	0.868	0.5	"
0.188	12.7	1.3	0.873	0.5	"
0.188	5.7	2.0	0.910	0.5	"
0.188	4.3	1.3	0.90	6.5	"
0.188	2.8	1.3	0.80	6.5	"

The effect of the ratio of tray thickness to orifice diameter on orifice coefficient of discharge may be explained on a theoretical basis. The dry tray pressure drop may be considered equal to the sum of a contraction loss due to the constriction of the streamlines of flow entering the orifice and an expansion loss due to the expansion of the stream filaments from the orifice vena contracta to the column cross section downstream from the plate. If orifice coefficients of discharge are calculated over a perforation area range from zero to 20 percent for the limiting case of a tray thickness great enough so that the vena contracta is located at the throat of the orifice and is equal to the orifice diameter, the coefficients of discharge calculated from the sum of the contraction and expansion losses correspond to those shown for a ratio of tray thickness to orifice diameter of 1.3.

Referring to Figure 4, a diagrammatic representation of a thick plate orifice, the contraction loss for the flow of a fluid from Point i to Point o is given by the following equation:

$$\frac{\Delta P_c}{\rho} = K\frac{u_o^2}{2g_c} \qquad (11)$$

where K is the contraction coefficient and is dependent on the area ratio, (A_o/A_1) for Reynold's numbers (based on A_o) greater than 10,000
ρ is the fluid density
u_o is the linear velocity at Point o
g_c is the gravitational constant
ΔP_c is the pressure drop from point i to o

The expansion loss from Point o to Point d is given by the following equation:

$$\frac{\Delta P_E}{\rho} = \frac{\left[1-\frac{A_o}{A_d}\right]^2 u_o^2}{2g_c} \qquad (12)$$

where ΔP_E is the expansion loss for flow from Point o to Point d,

$$\frac{\Delta P_c + \Delta P_E}{\rho} = \left[K+\left(1-\frac{A_o}{A_d}\right)^2\right]\frac{u_o^2}{2g_c} \qquad (13)$$

The pressure drop for flow through an orifice is:

$$\frac{\Delta P_o}{\rho} = \frac{u_o^2}{2g_c}\left(\frac{1}{C_o}\right)^2 \qquad (14)$$

Solving Equations (13) and (14) for the orifice coefficient of discharge, C_o, and assuming $A_1 = A_d$:

$$C_o = \sqrt{\frac{1}{K+\left(1-\frac{A_o}{A_1}\right)^2}} \qquad (15)$$

The calculated values for C_o are shown in Table 2.

For the limiting case of vapor flow through holes in a very thin perforated tray with a ratio of thickness to hole diameter less than 0.125, the vena contracta is located

TABLE 2
Calculated Values of Discharge Coefficient for a Thick-Plate Orifice

$\left(\frac{A_o}{A_1}\right)$	K	C_o
0.0	0.500	0.817
0.04	0.488	0.842
0.10	0.470	0.885
0.15	0.450	0.925
0.20	0.430	0.967

downstream from the orifice and is smaller in diameter than the orifice. Consequently, for a given percentage of perforation area, the sum of the contraction and expansion losses for a very thin plate orifice should result in a smaller value for the coefficient of discharge as shown in Figure 2. The effect shown for the percent perforation area is also anticipated since this variable enters the contraction and expansion loss calculation as shown in the derivation given in the preceding paragraph.

The coefficients of discharge shown in Figure 2 are applicable to 3/16-inch holes. Surface irregularities, nonuniformity of hole size and the fabrication difficulties encountered in punching 1/8-inch or smaller holes preclude the use of any holes smaller than 3/16-inch in industrial applications. In general, the most common design range for the ratio of tray thickness to hole diameter is 0.1 to 0.7. A lack of reproducibility in coefficient of discharge is indicated for ratios of tray thickness to hole diameter greater than 1.5.

The total vapor pressure drop per plate, P_T, is as follows:

$$P_T = L_{a_{avg}} + 0.186 \left(\frac{u_o}{C_o}\right)^2 \left(\frac{\rho_V}{\rho_L}\right) \quad (16)$$

What are the Maximum Vapor and Liquid Loadings?—The condition of maximum permissible vapor and liquid loadings is given by equating the value of L_D as determined from Equation (4) to 50 percent of the tray spacing.

$$L_D = 0.5\,H = L_{b_{avg}} + L_{a_{avg}} + 0.186 \left(\frac{u_o}{C_o}\right)^2 \left(\frac{\rho_V}{\rho_L}\right) + P_{dc} \quad (17)$$

where H = tray spacing in inches (between tray "a" and tray "b")

If the maximum vapor and liquid tray loadings are given, then Equation (17) may be solved by trial and error for u_o, the linear vapor velocity through the perforations at flowing conditions. The quotient of the volumetric vapor rate at flowing conditions and the hole velocity, u_o, is the actual effective perforation area required to insure operability at the maximum liquid and vapor rates to be encountered.

Minimum Vapor Loading—Tray weepage is generally the limiting factor in high liquid rate, low vapor rate services, e.g., stripping trays in the hydrofiner fractionators. The dry tray pressure drop, P_D, calculated from Equation (10) using the minimum vapor rate to obtain u_o, must be large enough so that weepage of the liquid through the plate perforations does not occur. This condition is satisfied if the calculated dry tray pressure drop is greater than that shown in Figure 3 at the greatest value of the static liquid seal height to be encountered at the minimum vapor rate.

The weepage curve shown in Figure 3 was derived from Mayfield's weep point data for the air-water system. Mayfield plots the maximum dry tray pressure drop at which weepage occurs versus a term he calls "clear liquid depth." This term is defined as the sum of the outlet weir height and the head of unaerated liquid over the weir (as calculated from the Francis weir formula). Mayfield defines an aeration factor as the ratio of the observed pressure drop through the liquid on the tray to the calculated "clear liquid depth."

Although Mayfield's definition of aeration factor differs from that suggested in this article, the product of Mayfield's aeration factor and the "clear liquid depth" is equal to the static liquid seal height on the tray. The data scatter shown on Mayfield's weepage correlation plot has been greatly reduced by plotting the maximum dry tray pressure drop at which weepage occurs versus static liquid seal height. It is conservative to assume an aeration factor of unity in checking for tray weepage.

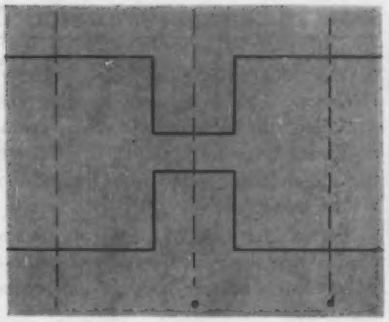

FIGURE 4—Thick plate orifice.

If weepage at the minimum vapor rate is indicated, there are several ways in which this situation may be corrected. The outlet weir height may be lowered, thus reducing the static liquid seal depth on the tray and reducing the tendency for weepage to occur. If this approach is taken, the design must be recalculated for the maximum vapor and liquid loadings. However, many investigators believe that a marked decrease in mass transfer efficiency results if the minimum static liquid seal depth on the tray is decreased below two inches. If the difficulty is due to very high liquid rates, it may be necessary to design a two-pass rather than a single-pass tray.

If the tray under consideration is already a two-pass tray and the variation in vapor and liquid rates is very great, an increase in the tray spacing may be warranted to insure a wide enough range of stable tray operation. However, in most services there is sufficient flexibility in the operating conditions that the minimum vapor rates can be increased to avoid the weepage limitation by lowering the tower pressure or increasing the use of stripping steam.

Tray Layout—The following general principles should be used as a guide in checking the suitability of an existing layout or in designing a new layout.

1. Downcomer inlet velocity (based on vapor-free liquid) should normally not exceed 0.4 feet per second to assure adequate area for vapor disengaging.

2. Downcomers may be sloped, with outlet area equal to one half of the inlet area. Sloped downcomers are normally more expensive than vertical downcomers and should be used only when they permit a significant increase in the plate perforation area.

3. The perforations used should be 3/16 of an inch in diameter and should be spaced on staggered centers (equilateral triangles) such that the pitch-to-diameter ratio is greater than 2.0 but less than 5.0 with an optimum of approximately 3.8. If a pitch-to-diameter ratio greater than five is indicated, then an active bubbling area should be provided across the center of the tray such that the pitch-to-diameter ratio is less than five and the remainder of the tray section should be blanked off.

4. If recessed inlet weirs are used to minimize impact head effects, the first row of perforations on the tray

may be located as close as two inches from the inlet weir. However, if no inlet weirs or non-recessed inlet weirs are provided, the first row of perforations should be located no closer than four inches from the line of projection of the downcomer edge (or the non-recessed inlet weir) on the tray.

5. The last row of perforations should be located no closer than four inches from the line of projection of the downcomer edge (or the non-recessed inlet weir) on the tray.

6. The last row of perforations should be located no closer than four inches from the outlet weir; and in order to allow for a tray support ring, no perforations should be located closer than three inches from the tower wall.

7. Trays should be installed absolutely level.

8. New trays should be inspected prior to installation to insure that smooth, round, square-edged holes are provided with a minimum of surface irregularities on the side facing the vapor flow.

Conclusion—The design method outlined in this article is conservative. The assumption of an aeration factor of unity for the liquid on the tray at both maximum and minimum loading conditions provides a margin of safety. The use of an aeration factor of 0.5 for the frothy liquid in the downcomer is common in the design of bubble cap trays. To permit more precise tray design calculations, experimental studies are very sorely needed to explore downcomer flow patterns and downcomer frothy liquid densities as a function of vapor and liquid rates and also system physical properties (using hydrocarbon systems). The allowance of a height of vapor-free liquid in the downcomer equal to one half the tray spacing instead of one half the sum of the tray spacing and the outlet weir height is conservative.

At minimum loading conditions, the use of an aeration factor of unity for the tray liquid in connection with weepage calculations should insure stable tray operation. Zenz's[11] weepage curves for ⅛ and ¼-inch holes for systems of lower surface tension than the air-water system are somewhat higher than Mayfield's[7] data for 3/16-inch holes. Weepage conditions are very likely a function of system surface tension, hole diameter and percentage perforation area. Weepage studies with hydrocarbon systems in towers of reasonable diameter are necessary to clarify this point.

Hunt's[3] data for entrainment from perforated trays in a 6-inch column show that perforated trays possess an important advantage entrainment-wise over bubble cap trays. However, entrainment data on large diameter perforated trays are necessary to quantitatively define this advantage in terms of critical vapor velocity before a reduction in tower diameter (compared to bubble cap trays) is safe.

The method of perforated tray design proposed in this article will help in outlining a procedure for obtaining tray designs which provide stable operation over reasonable ranges of vapor and liquid flow rates.

TABLE 3

Conditions for Design of Perforated Trays to Replace Corroded Bubble Cap Trays in Crude Oil Pipe Stills

Design Rates	Liquid B/D Hydrocarbon	CFS Vapor at Flowing Conditions		
		Hydrocarbon	Steam	Total
Maximum Rate	20,000	200	50	250
Minimum Rate	7,000	100	25	125
Molecular Weight	....	115	18	95.5
API Gravity	54.9	55.7		
Operating Conditions				
Temperature, °F		270		
Pressure, psig		18		
Tower Dimensions				
Inside Diameter, Ft.		15.5		
Tower Cross Sectional Area, Sq. Ft.		189		
Tray Spacing, Ft.		2.0		
Downcomer Area, Sq. Ft./Downcomer		14.0		
Downcomer Weir Length, Inches		124		
Clearance Between Downcomer and Tray, Inches		2.25		

Illustrative Example—

Problem:

The top three bubble cap trays in the atmospheric tower of a crude pipe still are subjected to severe corrosion and therefore require replacement or repair relatively frequently. Economic calculations indicate that substantial savings in labor and material could be effected by the substitution of Monel metal perforated trays for these bubble cap trays as replacement becomes necessary. The perforated tray replacements should be designed to accommodate the vapor and liquid rates shown in Table 3 and should possess a wide enough range of stable operation to cover the maximum and minimum loading conditions. If possible, the existing downcomers and tray support beams should be used in order to minimize cost.

Solution:

(1) The internal rates shown in Table 3 for maximum and minimum loading conditions are based on heat and material balances using extensive pipe still test data. To check the suitability of the existing downcomers, the downcomer inlet velocity (based on vapor-free liquid) must be calculated. This value should normally not exceed 0.4 feet per second to assure adequate area for vapor disengaging.

Downcomer area = 14.0 square feet/downcomer
Maximum liquid rate = 20,000 B/D
Liquid specific gravity at 60 F = 0.759
Thermal expansion factor from 60 to 270 F = 1.16
Volumetric liquid rate at flowing conditions = (20,000 B/D) (1.16) (5.6 cu. ft/B) (D/86,400 sec.) = 1.50 cu.ft/sec.

$$\text{Downcomer inlet velocity} = \frac{1.50 \text{ cu. ft./sec.}}{14.0 \text{ sq. ft./downcomer}} = 0.107$$

ft./sec. Thus, the existing downcomer area is adequate.

(2) Solve for the crest over the outlet weir using the Francis weir formula for rectangular weirs.

$$h_{ow} = \left(\frac{Q}{2.98\, L_w}\right)^{2/3} \qquad (6)$$

Q_{max} = (20,000 B/D) (1.16) (42 gal/B) (D/1,440 min.)
= 677 gal/min. at flowing conditions
L_w = 124 in.

$$h_{ow} = \left[\frac{677}{(2.98)\ (124)}\right]^{2/3} = 1.50 \text{ in. hot liquid}$$

(3) Set the outlet weir height using Equation (7)

$$h_w = 4.0 - h_{ow}$$
$$h_w = 4.0 - 1.50 = 2.50 \text{ in.} \qquad (7)$$

The maximum static liquid seal height is 4.0 inches of hot liquid.

(4) Assume no inlet weir is to be provided and solve for pressure drop for liquid flow through the clearance area between the downcomer and tray.

$$P_{dc} = 0.057\left(\frac{Q}{A_1}\right)^2 \qquad (8)$$

where A_1 = (124) (2.25) = 279 square inches

$$P_{dc} = 0.057\left(\frac{677}{279}\right)^2 = 0.36 \text{ inches hot liquid}$$

(5) Solve for maximum permissible dry tray pressure drop

$P_D = 0.5\,H - L_{b_{avg}} - L_{s_{avg}} - P_{dc}$

where $L_{b_{avg}} = L_{s_{avg}} = 4.00$ in. hot liquid
$P_{dc} = 0.36$ in. hot liquid
$H = 24$ in.
$P_D = 12 - 8.00 - 0.36 = 3.64$ in. hot liquid.

(6) Solve for perforation area required

$$u_o = 2.32\, C_o \sqrt{P_D\left(\frac{\rho_L}{\rho_V}\right)}$$

where $P_D = 3.64$ in. hot liquid

$$\rho_L = (0.759)\left(\frac{62.4}{1.16}\right) = 40.8 \text{ lb./cu. ft.}$$

Assuming the ideal gas law:

$$\rho_V = \frac{PM}{RT} = \frac{(32.7)\,(95.5)}{(10.71)\,(460+270)} = 0.40 \text{ lb./cu. ft.}$$

Use Figure 2 to find C_o:

$t = 0.1345$ in. (10 gage)
$D_o = 0.188$ in.
$t/D_o = 0.72$

Assume 4.0 percent perforation area required as a first trial. From Figure 2, $C_o = 0.717$

$$u_o = (2.32)\,(0.717)\sqrt{(3.64)\left(\frac{40.8}{0.40}\right)} = 32.1 \text{ ft./sec.}$$

$V_{max} = 250$ cu. ft./sec.

$$\text{Perforation area} = \frac{250 \text{ cu. ft./sec.}}{32.1 \text{ ft./sec.}} = 7.78 \text{ sq. ft.}$$

$$\text{Percent perforation area} = \frac{7.78}{189\text{-}28} = 4.83 \text{ percent}$$

From Figure 2 for $t/D_o = 0.72$ and 4.83 percent perforation area: $C_o = 0.725$

$$\text{Percent perforation area} = (4.83)\,\frac{0.717}{0.725} = 4.78 \text{ percent}$$

This is a close enough check. Thus, (0.0478) (189-28) = 7.70 sq. ft. perforation area required.

(7) Recheck for weepage at minimum flow conditions. Calculate the static liquid seal height.

$$Q_{min} = (677 \text{ gal./min.})\left(\frac{7{,}000}{20{,}000}\right) = 238 \text{ gal./min.}$$

$$h_{ow} = \left[\frac{238}{(2.98)\,(124)}\right]^{2/3} = 0.75 \text{ in. hot liquid}$$

$$L_{e_{avg}} = L_{b_{avg}} h_w + h_{ow} = 2.50 + 0.75 = 3.25 \text{ in. hot liquid}$$

Since the calculated static liquid seal height is greater than the clearance (2¼ inches) between the downcomer and tray, no inlet weir need be provided.

(8) Calculate dry tray pressure drop corresponding to minimum vapor rate.

$V_{min} = 125$ cu. ft./sec. at flowing conditions

$$u_o = \frac{125 \text{ cu. ft./sec.}}{7.70 \text{ sq. ft.}} = 16.2 \text{ ft./sec.}$$

$\rho_L = 40.8$ lb./cu. ft.
$\rho_V = 0.40$ lb./cu. ft.
$C_o = 0.725$

$$P_D = 0.186\left(\frac{u_o}{C_o}\right)^2 \left(\frac{\rho_V}{\rho_L}\right) = (0.186)\left(\frac{16.2}{0.725}\right)^2 \left(\frac{0.40}{40.8}\right)$$

$= 0.91$ in. hot liquid

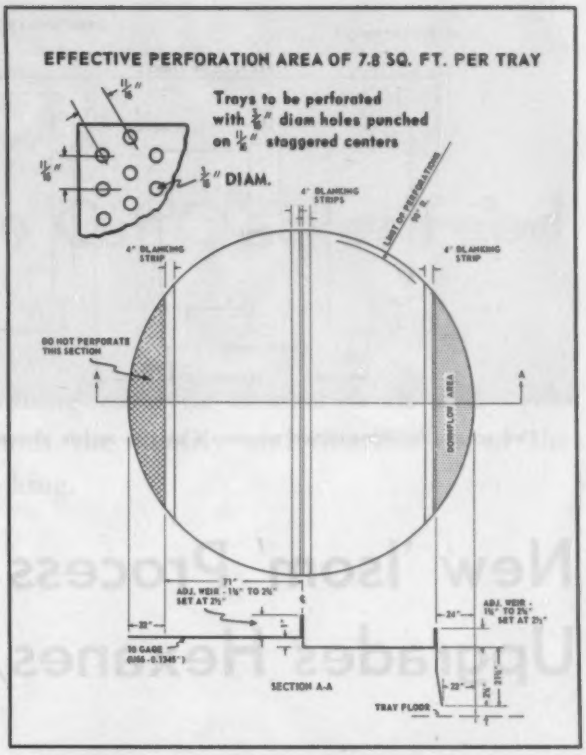
EFFECTIVE PERFORATION AREA OF 7.8 SQ. FT. PER TRAY
Trays to be perforated with 3/16" diam holes punched on 11/16" staggered centers
3/16" DIAM.
4" DIMENSION STRIPS
4" DIMENSION STRIP
4" DIMENSION STRIP
LIMIT OF PERFORATIONS
DO NOT PERFORATE THIS SECTION
DOWNCOMER AREA
ADJ. WEIR - 1½" TO 2½" SET AT 2½"
ADJ. WEIR - 1½" TO 2½" SET AT 2½"
10 GAGE (0.135 - 0.1345")
SECTION A-A
TRAY FLOOR

FIGURE 5—Perforated tray design for trays 32, 33 and 34 of atmospheric tower pipe still. Tray 33 oriented 180 degrees.

(9) Compare dry tray pressure drop calculated for minimum vapor rate with that necessary to prevent weepage obtained from Figure 3.

From Figure 3, at a static liquid seal height of 3.25 inches hot liquid, a dry tray pressure drop of 0.62 inches hot liquid is required to prevent weepage. Since the calculated dry tray pressure drop at minimum vapor rate, 0.91 inch of hot liquid, is 32 percent greater than this value, the tray as designed should provide stable operation at the minimum loading conditions.

(10) Calculate the hole spacing to be specified.

Total tray cross-sectional area available for perforations (less downcomers, calming areas, tray supports, etc.) = 116 square feet.

$$\frac{\text{Area of tray available for perforations}}{(\text{Spacing})^2\,(0.866)} = \frac{\text{Perforation area required}}{\text{Area per perforation}} = \text{Number of holes required}$$

$$\text{Spacing} = \sqrt{\left(\frac{\text{Area per perforation}}{\text{Perforation area required}}\right)\left(\frac{\text{Area of tray available for perforations}}{0.866}\right)}$$

$$= \sqrt{\frac{(1.92 \times 10^{-4})\,(116)}{(7.70)\,(0.866)}}$$

$= 0.0578$ ft. $= 0.693$ in.

A triangular hole spacing of 11/16 inches (i.e., 0.688 in.) using 3/16-inch holes corresponds to a perforation area of 7.80 square feet which is close enough to the desired perforation area.

(11) The final tray layout is shown in Figure 5. A summary of the design features is given in Table 4.

TABLE 4

Summary of Perforated Tray Design Features

Perforations	
Hole Size, Inches	3/16
Perforation Area, Sq. Ft.	7.8
Hole Spacing on Staggered Center, Inches	11/16
Inlet Weir Height, Inches	None
Inlet Weir Length, Inches	None
Outlet Weir Height, Inches	2½*
Outlet Weir Length, Inches	124
Downcomer to Tray Clearance, Inches	2¼
Liquid Depth, Inches	
Maximum	4.0
Minimum	3.25
Dry Tray Pressure Drop, Inches Water	
Maximum	2.38
Minimum	0.60

* Split level trays. 2½ inches center weir provided in order to use existing tray support members.

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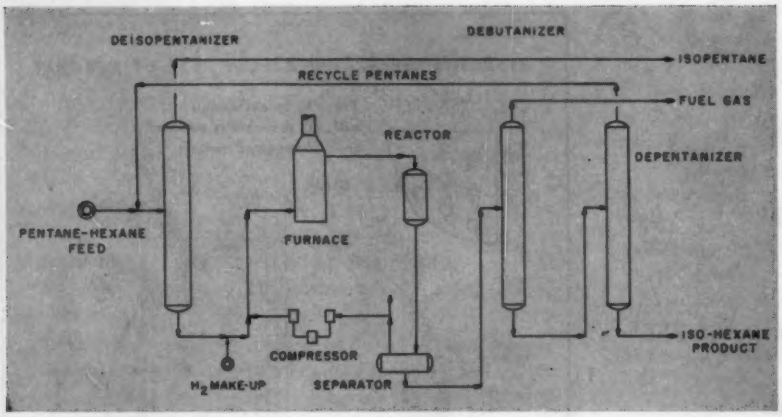

Flow scheme for isomerization process: It pays to recycle pentanes but not hexanes.

New 'Isom' Process Upgrades Hexanes, Too

THE NEW PROCESS, Iso-Kel, will isomerize hexanes as well as pentanes. Developed by The M. W. Kellogg Company, it is designed to help refiners increase high octane pool by upgrading front-end gasoline fractions. It's the fourth isomerization process to be announced within the past year.

Increasing the octane quality of straight-run naphthas and natural gasolines by isomerization of the pentanes and hexanes in one process unit offers marked economic advantages to refiners. (See box for research octane numbers of the pentane and hexane isomers.)

One advantage of the Iso-Kel process is that it produces two separate products: (1) an isopentane stream of 104.9 CFRR + 3 cc TEL, and (2) an isohexane stream of 89 to 92 CFRR + 3 cc TEL, depending on the feedstock. The isopentane stream can be allocated for the super premium gasoline; the isohexane stream for the housebrand. When charging light naphtha, the combined streams have an over-all yield of 97 vol. percent and an octane number of about 96 CFRR + 3 cc TEL. When feeding natural gasoline, over-all yield is 99 vol. percent and octane number about 99.8 CFRR + 3 cc.

The advantages of this new Iso-Kel process rest on a new, precious metal catalyst (not platinum) developed in Kellogg's research laboratories. This vapor-phase process requires only one reactor—which operates in the presence of hydrogen.

Economics of the Iso-Kel process are illustrated in the case of a 50,000 barrel-per-day refinery, where a 3100 bpd Iso-Kel unit would have a pay-out of about 19 months.

Processing Scheme—Depending upon quality of feedstock and degree of upgrading desired, the process flow sheet can be varied to allow for prefractionation of isomers in the feed, and recycle of unconverted material. Economic calculations indicate that, in general, it is preferable to process pentanes on a recycle basis, and to process hexanes once through.

The mixed feed is charged to a deisopentanizer, where it is joined by pentane isomerization product. The isopentane present in both the fresh feed and reactor product is taken overhead, and the bottoms are sent to the reactor. Hydrogen-rich gas is charged to the reactor with the feed, and separated from the effluent for recycle. The process is nearly self-sufficient for hydrogen, and only a small quantity of hydrogen make-up is necessary. The reaction product from the separator is debutanized and depentanized.

The hexanes are isomerized once-through, with only a small incremental investment over pentane isomerization alone. Further upgrading, at greater cost, could be achieved by the addition of a deisohexanizer and an auxiliary depentanizer, to remove the isomeric hexanes in the feed or to give complete recycle of n-hexane.

Yields and quantities calculated for processing three light naphthas of varying crude source are shown in Table 1. # #

How Octanes Compare in Gasoline Front-End

	Research Octane Number*	
	Clear	+3 cc TEL
n-pentane	61.7	88.7
i-pentane	92.3	105.7
n-hexane	24.8	65.3
2 methylpentane	73.4	93.1
3 methylpentane	74.5	93.4
2,2 dimethylbutane	91.8	104.3
2,3 dimethylbutane	102.7	108.9

*Octane numbers above 100 by formula: $ON = 128 - \frac{2800}{PN}$

TABLE 1
Yields on Pentane-Hexane Fraction From Commercial Stocks

	KUWAIT		MID-CONTINENT		NATURAL GASOLINE	
	Feed	Product	Feed	Product	Feed	Product
Total C_5-C_6						
Vol. Percent	100.0	97.3	100.0	96.7	100.0	99.2
Octane CFRR-Clear	63.7	77.7	62.1	77.0	72.3	83.3
+ 3 cc TEL	88.3	96.2	87.3	95.8	93.9	99.8
Pentane Fraction						
Vol. Percent of Total C_5-C_6	45.0	45.0	34.5	34.5	58.5	58.5
Octane CFRR-Clear	74.4	91.0	72.9	91.0	79.2	91.0
+ 3 cc TEL	95.8	104.9	94.9	104.9	98.4	104.9
Hexane Fraction						
Vol. & of Total C_5-C_6	55.0	52.3	65.5	62.2	41.5	40.7
Octane CFRR-Clear	54.9	66.3	56.4	69.2	62.2	72.2
+3 cc TEL	82.2	88.7	83.3	90.7	87.5	92.4

Catalytic hydrogenation has long been recognized as a method for upgrading low quality petroleum fractions. Since the advent of catalytic reforming, large quantities of by-product hydrogen are now available. In many instances hydrogenation has become desirable or even necessary if maximum efficiency of the reformer catalyst is to be obtained.

Hydrogen consumed in pretreatment of most reformer feeds is only a small portion of that produced by reforming. Much of this hydrogen is available for upgrading of heavier-than-naphtha fractions. Among such stocks, catalytic cracker fresh feeds and cycle oils offer an attractive return to the refiner who wishes to invest his hydrogen in the production of more and higher quality gasoline.

Improve Cat Cracker Feed

Unifining catalytic cracker feeds and cycle oils improves both the quality and distribution of the products of cracking.

G. W. Hendricks, H. C. Huffman, N. L. Kay, V. E. Stiles, E. C. Attane and T. V. Inwood
Union Oil Company of California
Brea, Calif.

WHEN A CATALYTIC cracker charge stock is hydrogenated, sulfur and nitrogen are removed, olefins are saturated, and polycyclic aromatics are partially saturated. The result is increased quality and improved distribution of the products of catalytic cracking. Cracked gasolines contain less sulfur and nitrogen, show greater stability and have higher octane numbers. Residual cycle oils contain less sulfur and nitrogen and show other characteristics which indicate improved quality as cracking feeds or midbarrel fuels. Also, less catalytic carbon is produced at constant conversion of the cracking charge.

These conclusions are based on data which were obtained in continuous flow, bench-scale units. The hydrogenation of the feed stocks was done with the same catalyst which is used in the commercial Unifining process, and the catalytic cracking employed a synthetic silica-alumina catalyst. A more detailed description of the Unifining process and the bench-scale equipment is given in the accompanying box.

The charge stocks exhibited widely different properties. These are reported in Table 1. The first is predominantly heavy vacuum gas oil from California (Los Angeles Basin) crude oil and is typical of charge stock currently fed to a commercial catalytic cracking unit. The second is predominantly cracked gas oil from the coking of California crude oils; the major component (50 percent) is from the coking of Santa Maria Valley crude oil. The third feed is a cycle oil from commercial catalytic cracking of the first stock, and the fourth is a cycle oil from commercial catalytic cracking of a Mid-Continent stock.

Unifining the vacuum gas oil at two severity levels gave the results shown in Table 2. The processing conditions for Test 1 were selected to give a chemical hydrogen consumption (hydrogen consumed by chemical reactions) of 400 cubic feet per barrel of feed. A liquid product containing 0.12 weight percent sulfur and 0.15 weight percent nitrogen was obtained in a yield of 101.5 volume percent of feed. The API gravity of the oil was increased 7 degrees.

In Test 2 the hydrogen consumption was increased to 675 cubic feet per barrel of feed. Removal of sulfur and nitrogen was more nearly complete, 96 percent and 92 percent, respectively. A greater increase in API gravity and greater reduction of bromine number were additional results

TABLE 1
Untreated Cracking Stocks

Number	1	2	3	4
Type	California Vacuum Gas Oil	California Coker Gas Oil	Catalytic Cycle Oil From 1	Catalytic Cycle Oil From Mid-ontinent Crude
Composition	Vac. Gas Oil—81.5% Coker Gas Oil—18.5%	Coker Gas Oil—90% Virgin Gas Oil—10%	Cat. Cycle Oil—100%	Cat. Cycle Oil—100%
Gravity, API	21.8	26.5	21.0	31.9
ASTM Distillation, F.:				
Initial Boiling Point	410	370	445	440
10 percent	570	465	470	480
50 percent	720	575	530	515
90 percent	910*	695	625	580
Maximum	950*	740	675	615
Sulfur, weight percent	1.16	2.34	0.89	0.22
Nitrogen, weight percent	0.36	0.30	0.13	0.025
Aniline Point (50/50), C	69.0	46.2	24.8	57.6
Bromine No. (Electrometric)	12	36	26	10

* Estimated from vacuum distillation.

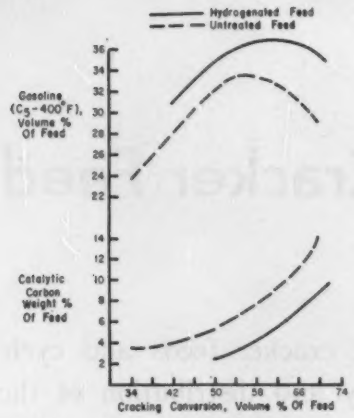
Hydrogenated Feed
Untreated Feed
Gasoline (C5-400°F), Volume % Of Feed
Catalytic Carbon Weight % Of Feed
Cracking Conversion, Volume % Of Feed

FIGURE 1—The hydrogenated feed has the advantage of producing more gasoline and less coke than the untreated feed.

of the higher hydrogen consumption. Liquid recovery was 102 volume percent of feed.

The last two columns of Table 2 show the characteristics of the stocks prepared from the raw feed and the Test 2 product for catalytic cracking studies. Each stock was distilled in an 18-theoretical-plate Oldershaw column at 20/1 reflux ratio to remove gasoline of 400 F. ASTM end point. This is the same distillation procedure employed to separate gasoline from residual gas oil after cracking. The data show that the hydrogenated gas oil contained 5 percent as much sulfur and 16 percent as much nitrogen as the raw gas oil, that Unifining increased the gravity almost 7 degrees API and the aniline point more than 7 C., and that 9.5 volume percent of the raw charge was converted to gasoline. Most of this gasoline was made in the reactions which eliminated sulfur and nitrogen from organic compounds.

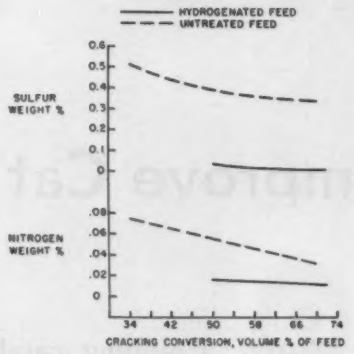

FIGURE 2—Less sulfur and nitrogen exist in a cracked gasoline produced from a hydrogenated stock.

Catalytic cracking then was carried out on the gasoline-free fractions from untreated vacuum gas oil and from the hydrogenated product. In this study, as in all of the cracking comparisons to follow, average reactor temperature was a constant and conversion was varied by changing the space velocity and the catalyst/oil ratio. All cracking data reported are for once-through cracking.

Figure 1 shows the gasoline and catalytic carbon yields as functions of the cracking conversion. The gasoline curve for the untreated feed passes through a maximum at about 56 percent conversion. At this conversion level the gasoline and the carbon yields from the hydrogenated stock were 108 percent and 53 percent, respectively, of those from the untreated stock. These curves illustrate another effect which is a characteristic result of Unifining catalytic cracker charge stocks: Unifining has increased the conversion level at which maximum gasoline was obtained. In the example shown this conversion level was about 62 percent.

TABLE 2
Unifining California Vacuum Gas Oil

	Charge	Test 1 Product	Test 2 Product	CRACKER CHARGE	
				Untreated	Test 2
Volume percent of Charge	100	101.5*	102*	96.5	87
Gravity, API	21.8	28.9	30.8	21.2	27.9
ASTM Distillation, F.:					
Initial Boiling Point	410	270	265	475	460
10 percent	570	430	420	590	520
50 percent	720	650	645	720	680
Maximum†	950	910	900	950	920
Sulfur, weight percent	1.16	0.12	0.05	1.18	0.06
Nitrogen, weight percent	0.36	0.15	0.05	0.37	0.06
Aniline Point (50/50), C.	....	....	....	69.6	77.0
Bromine No. (Electrometric)	12	7	4	12	5
Hydrogen Consumption, cubic feet/barrel of feed (60 F.)		400	675		

* C_5+ liquid product.
† Estimated from vacuum distillation.

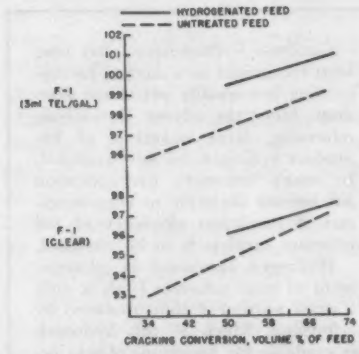

FIGURE 3—The greater gains in the leaded octane ratings reflect the lower sulfur content of the gasoline from hydrogenated stock.

Figures 2 and 3 compare the qualities of the cracked gasolines. In Figure 2 the sulfur and nitrogen contents of the C_5—400 F. gasolines are shown as functions of cracking conversion. At the 56 percent conversion level the gasoline from cracking of the untreated feed contained 0.37 weight percent sulfur and 0.05 weight percent nitrogen; that from the hydrogenated feed contained 0.02 percent sulfur and 0.015 percent nitrogen. At lower conversions the differences were greater.

In Figure 3 the Research Method (F-1) octane numbers of the C_5—400 F. gasolines are plotted against cracking conversion. Comparing again at the 56 percent conversion level, the unleaded and leaded ratings for the gasoline from untreated feed were 95.5 and 98, while the corresponding ratings for the gasoline from hydrogenated feed were 96.5 and 100. The greater gain in the leaded rating reflects the lower sulfur content of the gasoline from hydrogenated stock. Again the differences are greater if comparisons are made at lower conversions.

Other gasoline quality gains, not shown in the figures, were found in the results of various stability tests. As a result of Unifining the cracker feed, the catalytic gasoline showed an increase in induction period from 82 minutes to 275 minutes. The phenolics content decreased from 0.40 to 0.05 weight percent. The peroxide numbers, initially 0.12 and 0.04, increased after one month's storage at 110 F. to 1.75 and 0.50 in the gasolines from raw and hydrogenated feeds, respectively.

Figures 4 and 5 compare the quali-

ties of the total cycle stocks from the once-through cracking experiments. Figure 4 shows the sulfur and nitrogen contents. Over the conversion range from 50 to 60 percent the cycle oils from untreated feed averaged 0.90 weight percent sulfur and 0.24 weight percent nitrogen; those from treated feed averaged 0.06 percent sulfur and 0.04 percent nitrogen.

Figure 5 shows the API gravities and the aniline points of the cycle oils. The curves show that cycle oils from the cracking of hydrogenated fresh feed were 6.5 degrees higher in API gravity and 8-10 C. higher in aniline point than were those from cracking of the untreated feed. Thus, in addition to yielding more and better gasoline from catalytic cracking, Unifining of the fresh feed has resulted in a catalytic cycle oil of higher quality, either as additional catalytic cracker feed stock or as a blending stock for diesel fuel.

Commercial results were estimated from correlations between our bench-scale unit and a 30,000-barrel-per-day cracking unit, for once-through catalytic cracking of the untreated and the hydrogenated vacuum gas oils at 60 percent conversion and constant cracking temperature. The estimations are shown in Table 3. As a result of Unifining, 10 percent greater gasoline yield and 35 percent less catalytic carbon are predicted. The catalytic gasoline from the hydrogenated gas oil is virtually sulfur-free, shows a greatly reduced concentration of nitrogen, and is one and two numbers, respectively, higher in clear and leaded Research octane ratings than the catalytic gasoline from the untreated stock. Greater differences in sulfur and nitrogen contents are estimated for the residual cycle stocks, which also show a gravity difference of 6.5 API and a difference in aniline points of 8 C.

TABLE 3
Estimated Commercial FCC Yields From California Vacuum Gas Oil

FEED	Untreated	Hydrogenated
Conversion, vol. percent of Feed	60	60
Catalytic Carbon, wt. percent of Feed	10	6.5
Gasoline (C_5-400 F.), vol. percent of Feed	35	38.5
Sulfur, wt. percent	0.3	<0.01
Nitrogen, wt. percent	0.02	<0.005
Octane Numbers:		
F-1, Clear	94.5	95.5
F-1, with 3 ml. TEL/gallon	97.5	99.5
Cycle Oil:		
Gravity, API	16.5	23
Sulfur, wt. percent	0.8	0.01
Nitrogen, wt. percent	0.2	0.02
Aniline Point (50/50), C	43	51

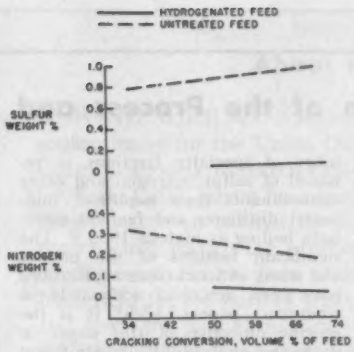

FIGURE 4—These data show that the removal of sulfur and nitrogen is reflected also in the total cycle oil product.

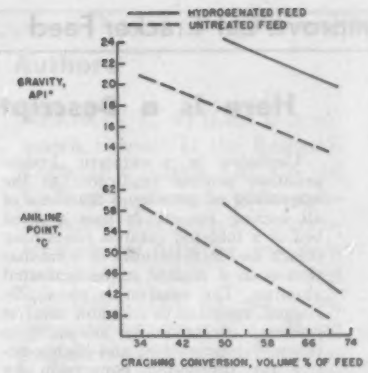

FIGURE 5—In addition to yielding more and better gasoline, hydrogenating feed produces cycle oil of higher quality for additional cracker feed or for diesel fuel.

The California Coker gas oil was employed in another unifining-catalytic cracking study; typical results are shown in Tables 4 and 5. The first two columns of Table 4 show results of Unifining at a hydrogen consumption level of 625 cubic feet per barrel of feed. The liquid yield was 101 volume percent of feed, the product gravity was 7.5 degrees API higher than the feed gravity, and the sulfur and nitrogen conversions were 97 percent and 77 percent, respectively.

The last two columns of Table 4 compare the characteristics of the gasoline-free fractions of the raw and hydrogenated stocks which were prepared for cracking tests. Here the gravity and aniline point differences were 6.5 API and over 14 C. The hydrogenated gas oil contained four percent as much sulfur and 28 percent as much nitrogen as the raw gas oil. The data show that 9.5 volume percent of the raw charge was converted to gasoline; this can be attributed largely to the hydrogenation reactions which eliminated sulfur and nitrogen from organic compounds.

Results of cracking the raw and hydrogenated coker gas oils at similar conversions are shown in Table 5. The increase in catalytic gasoline yield as a result of Unifining was less than for the vacuum gas oil, but the degree of reduction in catalytic carbon (29 percent) was similar and the improvements in gasoline and cycle oil quality were greater. The gasolines were distilled into light and heavy fractions. As a result of Unifining, the clear and leaded Research octane values of the C_5-320 F. gasoline were increased approximately one and two numbers, while the leaded octane rating of the 320-400 F. fraction was increased one number. The sulfur and nitrogen contents of the light gasoline were 0.02 weight percent and 0.009 weight percent, respectively, compared with 1.20 percent and 0.03 percent for the light gasoline from untreated gas oil. Again, the differences in nitrogen and sulfur contents are

TABLE 4
Unifining California Coker Gas Oil

	Charge	Product	CRACKER CHARGE	
			Untreated	Hydrogenated
Vol. Percent of Charge	100	101*	91.5	82
Gravity, API	26.5	34.0	25.1	31.6
ASTM Distillation, F.				
Initial Boiling Pt.	370	225	460	465
10 Percent	465	415	510	495
50 Percent	575	540	590	565
90 Percent	695	670	700	680
Maximum	740	740	740	745
Sulfur, Wt. Percent	2.34	0.07	2.42	0.09
Nitrogen, wt. percent	0.30	0.07	0.32	0.09
Aniline Point (50/50), C	....	....	52.6	66.4
Bromine No. (Electrometric)	36	5	31	4
Hydrogen Consumption, cubic feet/barrel of feed 60 F.)		625		

* C_5 + liquid product.

TABLE 5
Catalytic Cracking of California Coker Gas Oil

FEED	Untreated	Hydrogenated
Conversion, vol. percent of Feed	51.9	51.4
Catalytic Carbon, wt. percent of Feed	6.5	4.6
Gasoline (C_5-400 F.), vol. percent of Feed	27.4	28.1
Light Gasoline (C_5-320 F.), vol. percent of Feed	21.4	21.8
Sulfur, wt. percent	1.20	0.02
Nitrogen, wt. percent	0.03	0.009
Octane Numbers:		
F-1, Clear	96.2	97.1
F-1 with 3 ml. TEL/gallon	97.8	99.8
Heavy Gasoline (320-400 F.), vol. percent of feed	6.0	6.3
F-1, with 3 ml. TEL/gallon	98.6	99.5
Cycle Oil:		
Gravity, API	19.8	27.4
Sulfur, wt. percent	2.10	0.06
Nitrogen, wt. percent	0.17	0.06
Aniline Point (50/50), C	41.8	56.2

Here Is a Description of the Process and Lab Equipment Used

Unifining is a catalytic hydrogenation process applicable to the upgrading of petroleum fractions of all boiling ranges. It uses a fixed bed of a tableted catalyst containing cobalt and molybdenum in combination with a highly stable activated alumina. The catalyst is physically rugged, resistant to common catalyst poisons, exceptionally resistant to thermal deactivation, and highly active for promoting conversion by hydrogenation of organo-sulfur, -nitrogen and -oxygen compounds to hydrogen sulfide, ammonia, water and hydrocarbons. The catalyst remains active for long periods without regeneration, but is readily regenerated when necessary; its outstanding thermal stability permits repeated regeneration without loss of activity.

The Unifining process, offered for license by The Union Oil Company of California and Universal Oil Products Company, was introduced to the petroleum refiner early in 1954.[1,2] Since that time approximately 50 units, totaling almost 500,000 barrels of daily throughput, have been put in operation, are under construction, or are in the design stage. Objectives range from improvement of color, odor and stability of specialty fractions to removal of sulfur, nitrogen and other contaminants from naphthas, midbarrel distillates and fuel oil distillates boiling as high as 1050 F. The significant features of the process and many of its current applications have been described adequately in previous papers.[1,3,4,5,6] It is the specific objective of this paper to show the applicability of Unifining to the upgrading of catalytic cracker charge stocks and call particular attention to the resultant gains in quality and distribution of cracked products.

The test results presented in the accompanying article were obtained in continuous flow, bench-scale units. The Unifining unit contains up to 300 cubic centimeters of catalyst in a vertical, electrically heated reactor of 1.16 inches inside diameter. In the bench-scale experiments, separately metered liquid feed and hydrogen are mixed and passed through the preheat and catalyst bed sections of the reactor. The reactor effluent is cooled, gas and liquid are separated in successive high and low pressure separators, and all products are metered and analyzed. The liquid product is freed of hydrogen sulfide and ammonia by water and caustic scrubbing.

The laboratory catalytic cracking unit employs a moving bed of fluid cracking catalyst. The catalyst inventory in the entire system is approximately four pounds; the normal catalyst content of the reactor is about one-half pound. Catalyst is lifted with nitrogen gas to a hopper at the top of the unit. Catalyst and nitrogen are disengaged at this point and the catalyst passes by gravity flow through the regenerator, the reactor, a steam stripper, and finally to the bottom of the lift system. A constant catalyst level is maintained in each vessel and the flows of air, oil vapors and steam are countercurrent to the flow of catalyst. Metered liquid feed is vaporized and passed upflow through the reactor vessel. Hydrocarbon vapors leave the reactor and pass through a dehydrator, a condenser, and are then fractionated to obtain gasoline and cycle stock. All products of cracking are metered and analyzed. Catalytic carbon is determined by a combustion analysis of catalyst samples.

In all tests to be discussed the catalyst used was equilibrium synthetic silica-alumina cracking catalyst from a commercial fluid catalytic cracking unit of 30,000 bpd capacity. Correlations have been developed between this commercial unit and the bench-scale unit.

greater when the residual cycle stocks are compared. The API gravities and the aniline points of the cycle oils further demonstrate the benefits of Unifining.

The cycle oil from commercial fluid catalytic cracking of the California vacuum gas oil was used in a similar study. The results of Unifining at a hydrogen consumption level of 800 cubic feet per barrel of feed are given in Table 6. The high yield of C_5+ liquid product, the 5.6 API increase in gravity, and the increase of more than 10 C. in aniline point of the gas oil fraction, with only a modest decrease in average boiling point, are indicative that a major portion of the hydrogen was consumed in partial saturation of aromatics. Not more than 300 cubic feet can be attributed to olefin saturation and to the 98 percent and the 92 percent removal of sulfur and nitrogen, respectively. Because analytical data indicated no significant decrease in the concentration of aromatics, it appears that polycyclic aromatics were partially hydrogenated. That is the result desired for maximum production of high octane gasoline from catalytic cracking.

The third column of Table 6 shows the characteristics of the gasoline-free hydrogenated oil which was compared with the untreated feed in the catalytic cracking tests. Table 7 gives the results of these cracking tests. The gains in catalytic gasoline quality from Unifining of the cracker charge are apparent when the sulfur and nitrogen contents and the leaded octane numbers are compared. It is also apparent that an even greater advantage of Unifining the cycle oil lies in the improved product distribution on cracking. Partial saturation of the aromatic cycle oil resulted in a 5.4-fold increase in gasoline/carbon ratio and greatly increased susceptibility to cracking. The data shown for the hydrogenated stock are for cracking at 50 percent higher space velocity and 33 percent lower catalyst/oil ratio

TABLE 6
Unifining California Catalytic Cycle Oil

	Charge	Product	Hydrogenated Cracker Charge
Volume Percent of Charge	100	103	98
Gravity, API	21.0	26.6	26.0
ASTM Distillation, F.:			
Initial Boiling Point	445	405	435
10 Percent	470	450	465
50 Percent	530	510	525
90 Percent	625	605	610
Maximum	675	670	670
Sulfur, Wt. Percent	0.89	0.02	0.02
Nitrogen, Wt. Percent	0.13	0.010	0.011
Aniline Point (50/50), C.	24.8	....	35.2
Bromine No. (Electrometric)	26	....	3
Hydrogen Consumption, cubic feet/barrel of feed (60 F.)		800	

TABLE 7
Catalytic Cracking of FCC Cycle Oil From California Vacuum Gas Oil

FEED	Untreated	Hydrogenated
Conversion, vol. percent of feed	44.4	47.2
Catalytic Carbon, wt. percent of feed	9.4	2.4
Gasoline (C_5-400 F.), vol. percent of feed	21.0	28.9
Sulfur, wt. percent	0.18	0.01
Nitrogen, wt. percent	0.04	<0.005
Octane Numbers:		
F-1, Clear	99.4	99.0
F-1, with 3 ml. TEL/gallon	100.4	101.6
Cycle Oil:		
Gravity, API	15.1	21.3
Sulfur, wt. percent	1.14	0.02
Nitrogen, wt. percent	0.06	0.005
Aniline Point, (50/50), C.	9.0	26.6

than those employed with the untreated stock. Again, a substantial gain in quality of the residual cycle oil resulted from Unifining the cracker charge; analytical data indicate that this material is a better cracking stock than the untreated cracker charge.

Another example of the advantages of Unifining a catalytic cycle oil is presented in the last two tables. Table 8 compares the feed and product for a Unifining test on a Mid-Continent catalytic cycle oil. Once again the high yield and the increases in API gravity and aniline point were primarily due to partial saturation of aromatics; only about 20 percent of the total hydrogen consumed can be accounted for by olefin saturation and sulfur and nitrogen removal. In this experiment the treated product was not topped prior to cracking; it contained two volume percent of 400 F. end point gasoline not present in the untreated oil.

The cracking results are shown in Table 9. On this relatively low sulfur stock the enhanced cracking susceptibility of the oil and the improved distribution of cracked products were the outstanding benefits derived from Unifining. Space velocity and catalyst/oil ratio for cracking of the treated stock were 43 percent higher and 32 percent lower, respectively, than for cracking of the untreated material. A 4.2-fold increase in gasoline/carbon ratio resulted from hydrogenation. The principal product quality gain is seen on comparison of the residual cycle oils; here again, the cycle oil from cracking of the hydrogenated oil appears to be at least as good as the untreated cracker charge.

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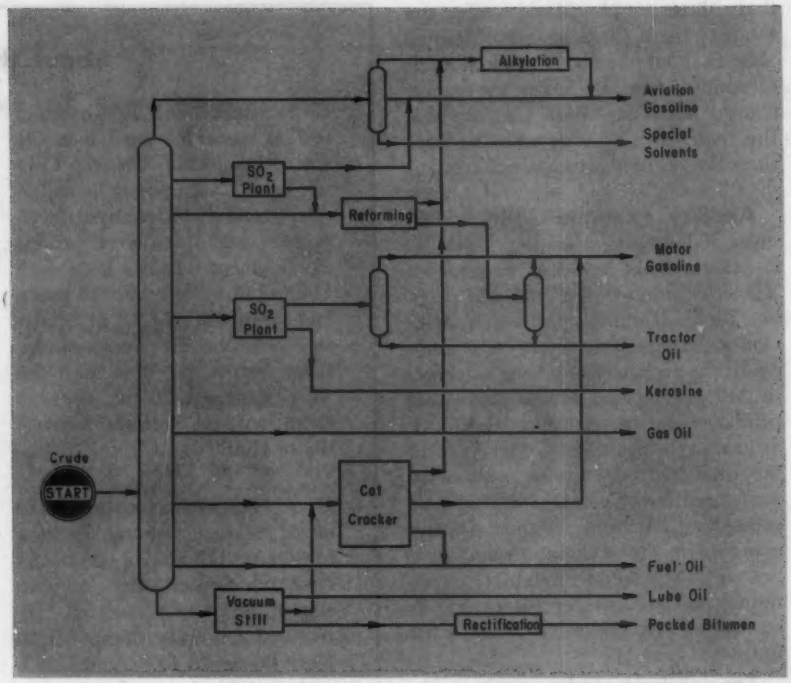
TABLE 8
Unifining Mid-Continent Catalytic Cycle Oil

	Charge	Product
Volume percent of Charge	100	102
Gravity, API	31.9	35.1
ASTM Distillation, F.:		
Initial Boiling Point	440	375
10 percent	480	465
50 percent	515	505
90 percent	580	565
Maximum	615	610
Sulfur, wt. percent	0.22	0.005
Nitrogen, wt. percent	0.03	<0.005
Aniline Point, (50/50), C.	57.6	62.0
Bromine No. (Electrometric)	10	1.5
Hydrogen Consumption, cubic feet/barrel of feed (60 F.)	450	

TABLE 9
Catalytic Cracking of Mid-Continent Catalytic Cycle Oil

FEED	Untreated	Hydrogenated
Conversion, vol. percent of Feed	47.9	46.8
Catalytic Carbon, wt. percent of Feed	8.5	2.7
Gasoline (C4-400 F.), vol. percent of Feed	19.9	26.2
Sulfur, wt. percent	0.03	<0.003
Nitrogen, wt. percent	0.010	<0.005
Octane Numbers:		
F-1, Clear	96.4	96.3
F-1, with 3 ml. TEL/gallon	99.8	100.0
Cycle Oil:		
Gravity, API	27.8	31.8
Sulfur, wt. percent	0.15	0.003
Nitrogen, wt. percent	0.02	<0.005
Aniline Point (50/50), C.	52.0	59.2

Abadan Refinery Continues Recovery



The Abadan refinery has the largest design capacity in the world—about 540,000 bpd.

This refinery is undergoing complete and selective overhaul. Throughput reaches 300,000 barrels daily as repairs progress.

IRAN'S OIL industry, virtually shut down during the three years following nationalization in 1951, is well on the road to recovery. Abadan, the world's largest in the sense that it has had the greatest crude charging capacity of any refinery in history, had an average daily throughput of about 240,000 barrels at mid-year of 1956. A general overhaul of the huge plant has been in progress ever since. Old units are being reconditioned and new ones are projected in accord with market conditions for different products.

Agreement of 1954—The Imperial Government of Iran, together with the National Iranian Oil Company, entered into an agreement signed on October 29, 1954, with a group, now called the Consortium, consisting of a number of international oil companies. Five U. S. companies each have a seven percent interest. These are Standard Oil Company (New Jersey), Gulf Oil Corporation, Standard Oil Company of California, The Texas Company, and Socony Mobil Oil Company. Nine other U. S. companies jointly own five percent interest; American Independent Oil Company, Hancock Oil Company, The Atlantic Refining Company, Getty Oil Company, San Jacinto Petroleum Company, Richfield Oil Corporation, Signal Oil and Gas Company, Tidewater Oil Company, and Standard Oil Company (Ohio). The remaining 60 percent interest is shared by The British Petroleum Company Ltd, 40 percent; Royal Dutch Shell, 14 percent, and Compagnie Francaise des Petroles, 6 percent. All companies or groups mentioned were original signatories to the agreement, and many of them have since transferred their rights to subsidiary companies. Two companies were formed by the nine U. S. companies jointly owning 5 percent interest were not original signatories to the agreement, but joined the Consortium later. Consortium to operate in the area governed by the agreement, which includes the known fields in South Iran. These companies are Iraanse Aardolie Exploratie en Productie Maatschappij N V (Iranian Oil Exploration and Producing Company), and Iraanse Aardolie Raffinage Maatschappij N V (Iranian Oil Refining Company), both incorporated in The Netherlands but with home offices in Teheran, Iran, Iranian Oil Participants Ltd., a British firm headquartered in London, was also formed by the Consortium as a holding company governing the shares of the two operating companies, proportioned according to the interests of each member company.

The 1954 agreement effects a partnership between the Consortium, and the Iranian government and its agency National Iranian Oil Company, owner of the oil reservoirs and of the oil field and refining equipment. The two operating companies of the Consortium are thus in charge of producing the oil within its area and refining it. The oil

is sold by subsidiaries of the 17 member companies. In return, the Consortium shares profits equally with the government. The National Iranian Oil Company markets within Iran, and carries out all phases of the business outside the Consortium area, including operation of about 3300 barrels daily of crude production from Naft-I-Shah field on the Iraq border. The field is connected by three-inch pipe line to a small refinery at Kermanshah, 100 miles eastward, and products are consumed locally. Late in August, 1956, Iran Oil Company, subsidiary of NIOC, brought in a prolific wildcat oil discovery near Qum, in Central Iran.

Abadan—Survey, Overhaul and Mounting Throughput—Abadan was not shut down completely during the nationalization dispute, as it supplied Iran's domestic product needs during this period. Immediately after conclusion of the 1954 agreement, Iranian Oil Refining Company made a careful study of the huge refinery, and began to recondition some units. A general overhaul of the plant is in progress, with 4500 men working on it. About two more years will be required to finish the job. Maintenance and construction work is, of course, under way also. Distribution systems, power plants, river-craft overhaul, air-conditioning, and a host of other relatively routine projects are keeping a force of 16,000 men busy, as compared to the 4200 men employed in actual refining operations.

Three large distillation units currently are in operation. Average daily crude throughput was 203,140 barrels daily during the first five months of 1956, rising from under 200,000 to 241,000 barrels daily in July with slight falloff thereafter. By contrast, average daily throughput in 1955 was 152,000 barrels per day. Middle distillates and fuel oil comprise the main yield. Two vacuum distillation units produce feedstock for manufacturing plants which supply lube oil for domestic consumption. A bitumen plant fulfills rapidly mounting domestic needs (reflecting increased highway construction) and provides a surplus for export. Considerable aviation gasoline is now being produced, with two isomerization and alkylation units operating. A big cat cracker, with a daily capacity of 30,000 barrels, has been in operation since its overhaul was completed on November 5, 1955.

About one-half to two-thirds of the products from this refinery are sent eastward. Therefore, the greatest impact of the Suez situation was to cause some uncertainty in the supply of tankers. Nevertheless, the output of this refinery continued to grow. Here is a table showing the throughput of the refinery during this period.

1956	Thousand Bbls. Per Day
January	140
February	210
March	210
April	230
May	229
June	227
July	241
August	205
September	241
October	267
November	299

Two more isomerization units may be brought back into use, in addition to the one currently operating.

Gas is being used to a large extent to fuel the refinery. A former crude pipe line between Agha Jari field and Abadan has been converted to natural gas for this purpose.

No special techniques have been employed to rehabilitate the refinery, standard procedures being used for what is essentially a normal overhaul.

On paper, the Abadan refinery still has the largest charging capacity in the world, about 540,000 barrels daily. Thus it will probably remain the world's largest from this viewpoint for some time. There is some discussion of boosting Creole Petroleum Corporation's Amuay Refinery in Venezuela to 500,000 barrels by 1960. Currently, Amuay has a capacity of 300,000 barrels daily. Lago Oil and Transport Company Ltd's Aruba Refinery is running more crude than any other, 440,000 barrels daily, with a rated maximum of 480,000 to 500,000 barrels daily. Esso's huge Baton Rouge plant is rated at about 315,000 barrels daily and is running 300,000; Humble's 282,000 barrels daily capacity plant at Baytown is running 250,000 barrels daily; Gulf's 272,000 barrels daily Port Arthur refinery is running at about capacity; and The Texas Company's 230,000 barrel capacity plant in the same city is running about the same amount of crude as Abadan. Refineries charging crude in the 180,000-220,000 barrels daily range include Ras Tanura in Saudi Arabia, Bahrain, and Royal Dutch/Shell's refineries at Pernis, Netherlands and Curacao in the West Indies. All these plants were either superior or comparable to Abadan in throughput, prior to the blocking of the Suez Canal.

The Consortium is obligated to try to refine about half of Iran's crude production at Abadan. Crude production in May, 1956, had reached 556,000 barrels per day, or more than twice the amount being refined at Abadan. The group's goal was 637,500 barrels daily production by the end of 1956 equal to Iran's peak year (1950). Actually, marketability is the factor dictating the proportions of crude and different products produced and sold. The primary goal of both the Consortium and the Iranian government in this venture is to increase revenues. Formerly the only large oil producer in the Middle East, Iran now finds itself with stiffer competition for the world's markets than in 1950. Iran's normal product markets, east of Suez, are now an area with greatly expanded refining capacity. Refining capacity in west-of-Suez consumer areas, particularly Europe, has risen too. This explains the tendency of Iran's crude production figures to run away from Abadan's throughput, though both have been mounting rapidly.

Personnel—Each of the two operating companies is governed by a seven-man board of directors, three of whom are Iranians. In each case, one of the Iranian directors is appointed by the shareholders, the other two by NIOC. In South Iran, each company has a general field manager, with the refining company's manager at Abadan, the producing company's at Masjid-i-Sulaiman. Each company has a coordinating group assisting the general manager, which for the refining company is composed of three Iranians and one foreigner.

There are, under this group, eleven departmental managers in each company, including four Iranians. The refining company has a staff of about 4400 including 250 non-Iranians. Total staff of both operating companies includes 330 non-Iranians and 4920 Iranian nationals. In addition, the Refining company has 25,500 field employes, all Iranian, at Abadan, and 17,350 Iranian oil field workers are employed by the producing company. Thus the operating companies have a total of about 49,000 workers, including only 330 non-Iranians.

##

Cooling Water Treatment – A Review

This review discusses many of the problems associated with the use of cooling water in a plant and suggests methods of treatment.

Maxey Brooke
Old Ocean, Texas

THE FIRST objectives of cooling water treatment, scale and corrosion control, are so closely related that they should be treated as one subject. This statement is based on the fact that practically all waters are either scale-forming or corrosive.

The scale-forming constituents are calcium and magnesium salts. Their scale forming tendency is a result of their inverse solubility with temperature. If cooling water comes into contact with a heated surface whose temperature exceeds the solubility temperature of these compounds, they will precipitate on that surface.

By the very nature of the evaporative cooling process, water is brought into intimate contact with air, saturating it with oxygen. It is said that there is no known combination of elements more corrosive than the system oxygen-water. If this oxygen-bearing water comes into contact with bare metal, corrosion occurs.

The earliest attempts to prevent scale and corrosion were to use a naturally soft water and to blowdown the tower heavily, thus preventing the concentration of the scale forming constituents. Because calcium and magnesium salts are increasingly soluble with decreasing pH, sulfuric acid was sometimes used. Even then, pH's were held only as low as about 7.5. Chromates in relatively high concentrations, 500 ppm or more, were added to inhibit corrosion. This was expensive, the downwind side of the tower left unsightly chromate deposits on the ground and surrounding equipment, and the blowdown was difficult to dispose. The use of organic chromates was of some benefit in that lower concentrations could be used.

Polyphosphates were used to some extent both as corrosion inhibitors and sequestrants (materials which would hold calcium and magnesium salts in solution). Organic materials such as lignins and tannins also were used with the idea that they would tend to cause the scale forming constituents to sludge so that they could be blown down rather than adhere to the metal surfaces. These met with indifferent success.

Langlier[9] proposed that the tendency of water to form scale or corrode could be calculated by the formula

$$pH - pH_s = \text{saturation index.}$$

A positive number indicated scale formation, a negative number indicated corrosion. The larger the number the greater the tendency. Larson and

Here are the objectives of cooling water treatment.

1. **To prevent scaling of cooling surfaces by:**
   - **A. Removal of scale-forming constituents with external treatment using:**
     - **a. Lime-soda softening.**
     - **b. Ion-exchange softening.**
   - **B. Keeping scale forming constituents in solution with internal treatment by:**
     - **a. Lowering the pH with acid.**
     - **b. Sequestering with a chelating agent.**
2. **To prevent corrosion of metal in contact with cooling water by:**
   - **A. Controlled scale.**
   - **B. Corrosion inhibitors.**
   - **C. Cathodic protection.**
3. **To prevent fouling of cooling surfaces and of the cooling tower itself by:**
   - **A. Algae control.**
   - **B. Slip-stream filtration.**
4. **To prevent deterioration of the cooling tower lumber by:**
   - **A. Chemical treatment of the wood.**
   - **B. Chemical treatment of the water.**
   - **C. Using construction materials other than wood.**

Buswell[10] modified Langliers method for calculating pH_s.

Another way it may be calculated with sufficient accuracy is to use the relation

$S.I. = 22.7 - 2(\log Ca + \log Alk) - pH_o$

where

S.I. = stability index
Ca = ppm calcium expressed as $CaCO_3$
Alk = ppm total alkylinity expressed as $CaCO_3$
pH_o = actual pH of the system.

This assumes a film temperature of the water on the exchanger tubes of 140 F. and a total dissolved solids content of 2000 ppm or greater.

Ryznar[16] proposed that for recirculating waters, the Langlier index be modified so that the tendency to scale or corrode could be calculated from the formula

$2pH_s - pH =$ stability index.

All values are positive and values of the index above 6.5 indicate a corrosive tendency while values below 6.0 indicate a tendency to scale.

For want of anything better, the Langlier and Ryznar indices were used extensively during the early 1940's. The idea was to adjust the composition of the water, usually by acidizing, so that a scale was laid down on the heating surfaces, thick enough to protect the metal against corrosion but thin enough so that it did not materially decrease the heat transfer. This was called the "controlled scale" method.

While it proved satisfactory for applications having a low temperature differential across heat exchangers, many process industries have varied temperature requirements. If the water were controlled to protect in high temperature services, those exchangers at lower temperatures would corrode. And if the lower temperature applications were protected, the higher temperature exchangers scaled. In fact, many instances are known where the hot end of an exchanger scaled while the cool end corroded. Only the center section was protected.

Many elaborate charts and tables for making these types of calculations have been published. One of these methods is accredited to Fitzpatrick.[6] Here is an example using the data given in Table 1.

Total Solids = 500 ppm, then S = 0.2
Temp = 100 F, then T = 1.7
Hardness = 139 ppm, then H = 1.8
Alkylinity = 230 ppm, then A = 2.4
pH = 7.5

Applying the equations

$pH_s = (9.3 + S + T) - (H + A).$

$= (9.3 + 0.2 + 1.7) - (1.8 + 2.4).$
$= 7.0$

Then

$S.I. = 2\,pH_s - pH$
$= 2(7.0) - 7.5$
$= 6.5$

This shows that an exchanger surface at 100 F. would have a thin protective scale. But if the water were used on a surface at 140 F., the stability index would be 5.7 which is in the scaling range.

Present day cooling water treatment was first called "high phosphate — low pH" treatment. "High phosphate" because the concentrations of polyphosphate were carried much higher than in the so-called "threshold" treatment, e.g., 30 to 50 ppm as compared to 3 to 5 ppm; and "low pH" because the pH was controlled by acid addition to a much lower value (6.0-6.5) than in any previous treatment. The name now has lost its significance.

The theory behind this treatment is to carry the water on the acid side, keeping the calcium and magnesium salts in solution and making the water quite corrosive. A corrosion inhibitor then is added to keep this corrosion from taking place.

It is difficult to assign the credit for the discovery of his type of treatment. The earliest reference found is that of Palmer[13] who found that mixtures of polyphosphate and chromare or polyphosphate and persulfate in salt water were more effective corrosion inhibitors in combination than the sum of their individual effects. This is "synergism." In 1952, J. K. Rice[14] pointed out that polyphosphates plus many oxidizing materials exhibited this synergistic action and were suitable for use in recirculating systems.

In any event, the material first used in late 1947 was a mixture of 90 percent sodium septaphosphate and 10 percent potassium ferricyanide.[17] This proved very effective except in regions of very high or very low velocities. At high velocities, the water seemed to mechanically remove the adsorbed film of inhibitor leaving the metal free for general attack. At very low velocities, pitting occurred, probably because enough fresh inhibitor did not reach the metal to repair the film. This situation was remedied somewhat, in later preparations in which the ferricyanide to phosphate ratio was increased.

A new treatment—was introduced about two years later. It was

About the Author

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TABLE 1
Rapid Calculator for Calcium Carbonate Saturation

Total Solids (ppm)	"S"	Calcium Hardness (ppm $CaCO_3$)	"H"	Total Alkylinity (ppm $CaCO_3$)	"A"
50—350	0.1	10	0.6	10	1.0
400—1100	0.2	12	0.7	12	1.1
		14	0.8	14	1.2
Temperature (°F)	"T"	18	0.9	18	1.3
		23	1.0	23	1.4
		28	1.1	28	1.5
32	2.6	35	1.2	36	1.6
36	2.5	44	1.3	45	1.7
44	2.4	56	1.4	56	1.8
50	2.3	70	1.5	70	1.9
58	2.2	88	1.6	88	2.0
64	2.1	111	1.7	111	2.1
72	2.0	139	1.8	140	2.2
82	1.9	175	1.9	177	2.3
90	1.8	230	2.0	230	2.4
100	1.7	280	2.1	280	2.5
112	1.6	350	2.2	360	2.6
124	1.5	440	2.3	450	2.7
134	1.4	560	2.4	560	2.8
148	1.3	700	2.5	700	2.9
162	1.2	870	2.6	880	3.0
180	1.1	1050	2.7	...	..

Use Above Factors with Following Equation:
$pH_s = (9.3 + S + T) - (H + A)$

the so-called "dianodic" treatment consisting of a polyphosphate and a chromate. Tanzola[18] reported that the average penetration of steel in recirculating water containing 4-8 ppm polyphosphate was 21 mils/year (1 mil = 0.001 in.). The same water treated with 200 ppm sodium chromate showed a penetration of 3 mils/year. With the dianodic treatment, 40 ppm PO_4 and 20 ppm CrO_4, the penetration was 2 mils/year. However the dianodic treatment showed a 61 percent reduction in pitting compared with the chromate and a 92 percent reduction in pitting compared with the polyphosphate.

In addition to persulfates, ferricyanides and chromates as oxidizing agents, nitrites, zinc salts, cupric salts, chloriates, and permanganates have been used.

Plant data indicate that 30-40 ppm of total crystalloidal silica is effective in stopping corrosion of mild steel in industrial cooling waters containing upwards of 500 ppm chlorides and sulfates. Values of 8.6 pH and higher have an adverse effect which may be corrected by acidizing to a pH of 7.0-7.5. Magnesium hardness above 250 ppm as $CaCO_3$ greatly reduces the inhibitive action. It is desirable to maintain the magnesium hardness below 150 ppm as $CaCO_3$. Five to eight weeks are required to build up a protective film on both clean and rusted steel.[19]

The most recent treatments offered are a polyphosphate-chromate-zinc mixture and a fluoride-chromate mixture. There is not enough data available to evaluate these treatments, but from preliminary reports they appear promising. The fluoride-chromate treatment is especially good in waters with a high alumina content. Phosphates are unfavorable since they react with alumina.

A suggested treatment for waters used in aluminum towers or systems containing aluminum tubes is a mixture of polyphosphate, citrate, and mercaptobenzothiazole.[15] The chromate-fluoride treatment also can be used.

Preventing Scale by External Treatment—It is obvious that the removal of scale forming constituents from cooling water before it is recirculated is an ideal way of reducing scale. This is usually done by the lime-soda or ion exchange process. Many excellent articles and books have been written on these subjects and they go beyond the scope of this article.

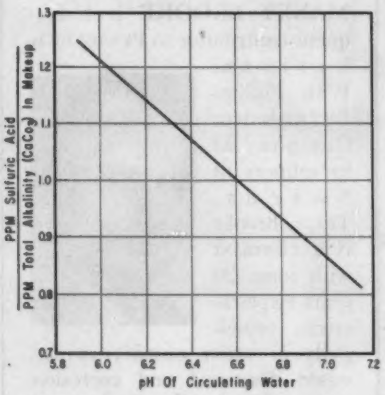

FIGURE 1—Although the amount of sulfuric acid required to obtain a given pH for the circulating water depends on a number of factors, this chart may be used for estimating purposes.

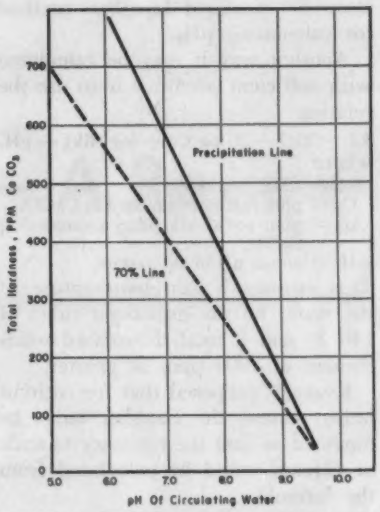

FIGURE 2—There is a limit to the amount of hardness which may be permitted in cooling water. Usually the water is not allowed to exceed 70 percent of this limit.

Preventing Scaling by Internal Treatment—This is most commonly done by lowering the pH with sulfuric acid or sulfur dioxide.[20] The pH should be controlled within rather narrow limits, 6.0-6.5. The amount of sulfuric acid needed depends upon a number of factors and usually must be determined experimentally. For estimating purposes, Figure 1 may be used. It was calculated from a number of Gulf Coast towers operating at various pH levels.

The limit to which the circulating water can be concentrated is governed by the hardness of the water and its pH. Figure 2 shows the hardness values at which precipitation takes place for any given pH when phosphates are present. It is not desirable to carry the hardness value of the circulating water higher than 70 percent of the value on the chart. On the other hand if the pH is carried below 6.0, the inhibitive effect of the corrosion treatment is reduced. At pH of 4.5 it has no effect, and at a pH of 2.0 the synergistic effect is actually reversed.

A steel specimen in contact with water having a pH of 2.0 showed a weight loss of 0.006 grams in 3½ hours. When 300 ppm of a polyphosphate-chromate inhibitor was added, the weight loss increased to 0.0173 grams and with 300 ppm polyphosphate-ferricyanide inhibitor, the loss was 0.1583 grams. It should also be noted that this type of treatment accelerated dezincification of uninhibited admiralty.

The use of sequestering agents is not widely practiced in cooling water treatment because of their instability under varying temperature conditions. Sequesterants used include ethylenediamine tetracetate, citric acid, gluconates, etc.

Preventing corrosion by controlled scale has been discussed. The recommended dosage for the synergistic treatments is 60 ppm in the circulating water. This value divided by the cycles of concentration will give the dosage for the makeup water.

To recapitulate, the four most commonly found scaling materials in cooling water and the method for controlling them are as follows:

1. **Calcium carbonate**—If the controlled scale method is being used, maintain the stability index at 6.0. If polyphosphates only, are being used, maintain the stability index above 4.0. If a synergistic treatment is being used, enough acid will be added to remove any carbonate ion, effectively preventing this type of scale.
2. **Calcium sulfate**—Control the blow-

These Bugs Can Give Trouble

Organisms which may prove troublesome in recirculating cooling water are classified in three main groups: bacteria, algae, and fungi. Slime growths in piping and exchangers are generally the result of bacterial formations although not all bacteria are slime formers. These organisms are listed as follows:

1. *Escherichia coli.*
2. *Aerobacter aerogenes.*
3. *Aerobacter cloacae.*
4. *Flavobacterium (species).*
5. *Bacillus megatherium.*
6. *Bacillus subtilis.*
7. *Bacillus pumilus.*
8. *Bacillus cerens.*
9. *Bacillus achromobacter (species).*

The corrosive group include the sulfate reducing bacteria or *Sporovibro desulfuricans.* These organisms are harmful because they reduce the sulfate content of the water to the corrosive sulfide ion.

The iron depositing group are responsible for the formation of hydrous iron oxide deposits in the cooling system. These organisms utilize soluble iron and deposit insoluble iron oxide in the slimy sheath around their cells. *Crenothrix, Gallionella,* and *Leptothrix* are the most common iron bacteria. *Crenothrix* and *Leptothrix* may also deposit manganese.

While bacteria occur in the piping and the cooling system, algae grows in the tower where they have access to light and air. Algae masses growing in the tower restrict the flow of water and air, add weight on the structural members, as well as sloughing off to cause fouling. The principal algae growths are:

1. *Cyanophyceae*—blue-green.
2. *Chlorophyceae*—green.
3. *Chlorophyceae*—yellow-green.
4. *Diatomaceae*—diatoms.
5. *Phaeophyceae*—brown.
6. *Rhodophyceae*—red.

The blue-green and green algae are the most troublesome in cooling towers, although diatoms have been found in fouling deposits.

down and the acid addition such that the product of the calcium in ppm and the sulfates in ppm is less than 500,000 in the circulating water.

3. **Calcium phospate**—Control hardness and pH of the circulating water so they fall in the safe region of Figure 2.
4. **Silica**—Maintain the silica content of the circulating water below 200 ppm.

Laboratory methods for evaluating cooling water inhibitors can be very misleading. Five different inhibitors were evaluated by four different laboratories.[11] The results are shown in Table 2.

None of the laboratories rated the inhibitors in the same order. For example, phosphoric acid, known to have little inhibiting value, received a high rating in some cases.

TABLE 2
Laboratory Ratings of Inhibitors

Laboratory	Rating of Test				
	1st	2nd	3rd	4th	5th
1.....	B	A	E	D	C
2.....	A	D	E	B	C
3.....	E	C	B	A	D
4.....	(A tied D)		C	E	B

The inhibitors (unknown to the laboratories) were:
A. Chromate-glucosate
B. 85% phosphoric acid
C. Zinc-polyphosphate
D. Chromate-polyphosphate
E. Ferricyanide-polyphosphate.

Fouling is distinguished from scaling in that fouling deposits are formed from material carried in suspension in the recirculating water while scaling deposits are formed from material carried in solution. Frequently the two occur together and the results of such deposits are much worse than either alone.

Materials which cause fouling can enter a tower in five ways: as silt or suspended solids in the make-up water, airborne dirt and particles carried into the tower by incoming air, material such as oil, leaking into the recirculating water from the process which it serves, deterioration of the tower lumber, and by biological growths within the tower. This last factor is probably the most serious fouling problem and the most difficult to combat. See the accompanying data for descriptions of these organisms and the chemicals which may be used to combat them.

In addition to fouling, tests[2] have shown that filtering cooling water reduced its corrosion rate from 8.6 to 1.3 mils per year. Forbes[7] reports that ¾-inch nipples exposed 500 hours with 3 gpm circulation had a corrosion rate of 8.4-10.0 mils per year using unfiltered water. The rate was reduced to 3.0-3.7 mils per year using the same water filtered. These masses of living matter can reduce cooling by impeding the flow of water by their actual bulk; they can interfere with the flow of heat and cause debris to collect which aggravates the situation. The gelatinous nature of these growths forms a very effective semi-permeable membrane that accelerates corrosion by forming oxygen concentration cells. The same membrane that causes the corrosion also prevents any corrosion inhibitor from reaching the metal where it is needed.

In conclusion, it can be said that in small installations, 10,000 gpm circulation or less, the most economical algaecide is one of the solid chemicals. Since organisms build up an immunity to these chemicals, it is best to alternate them. Say, one month with a copper base algaecide and the following month with a pentachlorophenol. In larger installations, chlorination is preferred. Whether continuous or intermittent feed is used is a matter of conditions existing in the cooling tower under consideration.

Suspended materials in the makeup water can be removed by sedimentation, flocculation or filtering before they enter the tower. One company reported that water containing 100 ppm suspended solids was pumped into a 15-acre retention basin for sedimentation. However the water taken out of the basin had 125 ppm suspended solids. The basin was treated with three pounds rotonone per acre foot; consequently, about 400 pounds of fish were killed and removed. Within two days the suspended solids in the water from the basin dropped to 15 ppm and remained at that level. It has also been reported that the addition of 100 pounds per acre foot of a 16-20-0 commercial fertilizer (16 percent nitrogen, 20 percent available phosphoric acid, 0 percent potash) would eliminate moss and algae in reservoirs without killing the fish.

Material can be prevented from entering the water from the process by proper maintenance, but airborne fouling material is more difficult to control. Location of the tower near a well traveled dusty road should be avoided. Personnel should be instructed not to throw debris into the basin. Hardware cloth around the

FIGHT THE BUGS WITH THESE

A number of chemicals have been used to combat biological growths. Among them are the following:

Copper salts—One of the oldest and most widely used algaecides, its toxicity is due to the presence of the copper ion. Since the amount of copper required to kill different types of algae varies considerably, it is desirable to study the particular organism in the system so the necessary dosage may be applied.

The effectiveness of copper sulfate in the control of organisms is nullified at the higher pH ranges since the toxic copper ion is precipitated as insoluble copper hydroxide.

Copper sulfate solutions are corrosive to iron and steel and therefore corrosion resistant feeding equipment is needed.

Study has revealed that any aliphatic hydroxy acid or its water soluble salt would render copper ions soluble in alkaline waters if the proper quantities of these organic chemicals were properly mixed with the copper salt before entering the water to be treated.

Figure 3 shows the quantities of some of these aliphatic hydroxy acids that were found necessary to keep copper sulfate from precipitating out in alkaline water.[6] Figure 4 shows the loss of copper sulfate at various pH values with and without the organic acids.

In the control of slime and algae in cooling water systems, the copper sulfate or copper sulfate base algaecide is generally slug-fed. The dosage as well as the frequency of the feeding is usually governed by the results obtained.

Mercury compounds—These are very toxic toward algae and slime as well as toward human beings. For this reason they have not received wide acceptance. A number of organic mercury compounds have been produced in an effort to retain the bactericidal and algaecidal properties of mercury while reducing the toxicity and corrosive action of these materials. These include the various phenyl mercury compounds.

They are used only in very stubborn cases. Care should be exercised to prevent cooling water spray from contact with human beings and protective clothing should be worn when handling organic mercury compounds.

Potassium permanganate—It is a powerful oxidizing agent and possesses a high degree of toxicity toward micro-organisms. However dead organic matter will consume potassium permanganate as well as live, which will markedly increase the amount required. Another disadvantage is the precipitation of manganese dioxide as a result of the reduction of the permanganate. This is a fouling material in itself.

Quarternary ammonium compounds—They show effective toxicity toward slime and algae growths when used in relatively high concentrations. Some of these compounds also have powerful bacteriostatic properties (ability to prevent growth of organisms at low concentrations). Some have been found to volatilize in cooling towers and are thus lost; others react with or are adsorbed by organic matter and are thereby rendered ineffective. The presence of high salt concentrations in the water reduces their effect. As a result of these limitations, little application of these materials to industrial water slime control has been practiced.

Some quartenary compounds possess effective surface active properties and have been used in combination with other algaecides, their presence aiding in the penetration of the growths by the other toxicant. Alkyl dimethyl benzyl ammonium chloride is one of the many quarternary ammonium compounds commercially available.

Phenolic compounds—Some of these, particularly sodium pentachlorphenate, are widely used in industrial cooling water systems. This material is soluble and stable in alkaline waters and does not react with most organic and inorganic chemicals which might be present in the system. It has been reported that when sodium pentachlorphenate is used in a system contaminated with ammonia and expotsed to sunlight, the water becomes purple. This makes an unsightly waste disposal problem. Sodium trichlorophenate has also been used.

Slug feeding of the pentachlorophenate has proven more effective than continuous feeding. Usually enough chemical is added to establish a concentration of about 200 ppm in the recirculating water.

Slug feeding of algaecides is more economical and almost as effective as continuous feeding. When the concentration of the algaecide has fallen off to 25 percent of its initial concentration a slug of algaecide is added to bring it back to the initial value. A formula for calculating the frequency of the treatment is:

$$T = \frac{2.309V(\log i/f)}{L}$$

T = Time in days between treatments
V = Volume of cooling systems, gallons
L = Volume of blowdown, gallons/day
i = initial concentration, ppm
f = final concentration, ppm

When $i/f = 0.25$

$$T = 1.385V/L$$

In a system with 1,500,000 gallons capacity and 200 gpm blowdown, treatment would be every 7.22 days. To maintain a 50 ppm residual by continuous treatment, 866 pounds of algaecide would be required. Slugwise treatment would require 469 pounds per week.

Care must be exercised in handling chlorinated phenolic compounds because the dust is irritating to the mucous membrane and sensitive skin.

Success has been achieved in algae control by combining chlorinated phenols with copper. Satisfactory results can be obtained by slug-feeding the combination in the range of 60-100 ppm.

Chlorine—Because of its high toxicity and quick action, chlorine is widely used as an algaecide. A residual of 0.5 ppm will destroy most micro-organisms. But since chlorine acts on all oxidizable matter, organic material, hydrogen sulfide, ferrous iron, etc., the demand of the water must be satisfied before the necessary residual for toxicity can be built up.

Chlorine is stable in acid, neutral, and alkaline waters although its toxic effect is reduced somewhat under alkaline conditions. When large amounts of chlorine are required, it is generally obtained in the liquid form for economy and convenience, and fed to the system by means of a chlorinator. When relatively small quantities are needed, calcium or sodium hypochlorite can be used.

There is some controversy as to whether the best method of feeding is continuous or intermittent. Admittedly, intermittent feeding is less expensive than continuous. But in the opinion of the author, continuous feeding is more satisfactory. Intermittent feed will allow growths to build up and then slough off, increasing the fouling material in the tower.

High concentrations of chlorine, especially in alkaline water, should be avoided to prevent deterioration of cooling tower lumber. Since cooling water is normally not alkaline and toxic concentrations are quite low, there is little danger of any ill effect. However, one chlorine manufacturing company on the Gulf Coast uses massive doses of chlorine to control the pH in their tower, 500 pounds per day to a 25,000 gpm circulation system, maintaining a pH of 6.0-6.5 and a chlorine residual of 15 ppm. All heat exchanger fouling is said to be eliminated and no lumber (Wolmanized fir) deterioration has been observed in eight years use.

Biological growths build up an immunity to many algaecides but not to chlorine.

Bromine—It has many of the same properties and effects as chlorine. It is less subject to loss in the tower, it is less affected by sunlight. Being a liquid, it is easier to apply. However its use is more hazardous to operating personnel and, except in small applications, it is more expensive.

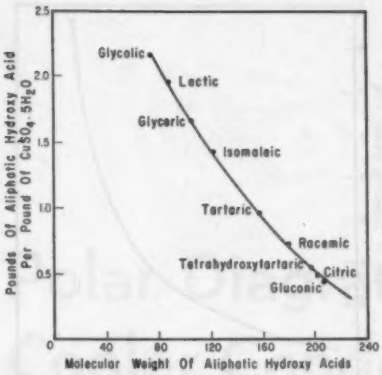

FIGURE 3—An aliphatic hydroxy acid or its water soluble salt will prevent copper from precipitating out of an alkaline water.

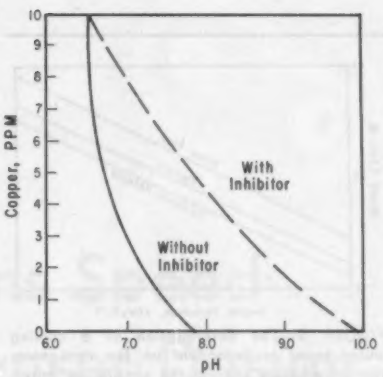

FIGURE 4—This is an indication of the effectiveness of an aliphatic hydroxy acid for retaining copper in an alkaline solution.

bottom portion of the tower is helpful. Coarse, easily cleaned screens on the pump suctions is a "must." This is helpful in keeping insects out of the system. In the spring, they are attracted at night in large quantities by lights and have been known to completely stop up a cooling system.

The preferred way to keep suspended solids from building up is the slip-stream or side-stream filter. This is simply a filtration unit that takes a portion of the stream from the circulating system, filters it, and returns it to the system. The filter can be either the pressure or gravity type and can operate with or without the aid of flocculation agents. Filter design is beyond the scope of this article. The side-stream rate should be 0.1-1.0 percent of the circulation rate. This allows the entire circulation to pass through the filter once every two to seventeen hours and is usually sufficient to keep the suspended solids to a minimum.

The size of a slipstream filter is a function of the blowdown and the percent solids removed.

$$FR = \left(\frac{100}{100 - R} - 1\right) BD$$

FR = Filtration rate, gpm
R = Percent removal of suspended solids desired
BD = Blowdown rate, gpm.

For example, a system contains 20 ppm suspended solids and has a blowdown rate of 200 gpm. It is desired to find the filter capacity needed to reduce the suspended solids to 5 ppm. The percent removal is $(20 - 5)/20 \times 100 = 75$ percent. Substituting this value in the formula, the filter rate is found to be 600 gpm. For other percent removals, the rate would be as follows:

Removal (%)	Filter Rate (gpm)
66.6	400
75.0	600
80.0	800
83.3	1000
85.7	1200
87.5	1400
88.9	1600
90.0	1800

It can be readily seen that at removal rates greater than 75 percent, the filter rate becomes excessive.

Cooling tower deterioration first came to public attention in 1949 when several towers, mostly on the Gulf Coast, failed. The sudden increase in tower failures was probably the result of several causes: the increased use of mechanical draft towers which are more susceptible to failure than are atmospheric towers, lowered construction standards during the late war, migration of industry to the south and west coasts where conditions for failure are more severe.

Wood is the most common material used in cooling tower construction because of its durability. The woods generally used are California redwood, cypress, and yellow pine. Douglas fir, white oak and Southern pine are sometimes used. The major constituent of wood is cellulosic material usually called cellulose which accounts for about half the dry weight.

Cellulosic material is fiberous in nature and consists of chiefly a chemically stable portion, alpha cellulose. The remainder is a series of lower molecular weight, less chemically stable material known as hemicelluloses. Alpha cellulose is hydrolyzed by dilute acids to polysaccharides, which in turn break down to sugars. The action of dilute acids is quite slow except at elevated temperatures.

Lignin is an amorphous material occurring in the cell wall and as a binder between the cells. It is attacked by alkalis as well as by oxidizing agents, but is insoluble in water.

While a tower is in operation, the wood is subjected to varying moisture conditions. Parts of the tower are constantly in contact with flowing water while others are subjected to mist. Some sections are intermittently splashed, parts are continuously submerged, parts are completely dry. As a result of these conditions, a number of types of deterioration are possible:

1. Erosion due to the impingement of falling water.
2. Leaching, which is selective due to the wide variation in the solubility of the components in the wood.
3. Chemical deterioration due to some of the components of the wood reacting with chemicals present in the water.
4. Decay due to micro-organisms that utilize the wood as food.

Chemical decomposition evidences itself by an apparent rotting of the lumber. The water seemingly extracts the lignin, leaving the wood in long stringy fibres and rendering the whole mass so porous that it is impossible to hold nails or other hardware in the lumber. The lumber itself, in time becomes so decomposed as to loose all its structural strength. This has been loosely defined as delignification.

Blohm and Frazier[3] studies the weight loss of wood samples in sodium carbonate solutions. Their results are shown in Figure 5. This work, coupled with a survey of some 500 towers, indicated that alkaline salts were responsible for chemical deterioration. The concentrations of sodium carbonate used were much higher than is normally found in cooling tower water. The author[4] determined the amount of lignin dissolved from redwood blocks in equilibrium tests and in actual cooling tower operation. Figure 6 shows the results of the cooling tower tests. By maintaining the pH of the circulating water below 7.5, this attack can be held to a minimum.

Biological deterioration is caused by fungi. Fungi belongs to the vegetable kingdom but differs from most plants in that they do not produce chlorophyll. They are unable to produce food by photosynthesis but must take their nourishment from organic

material. Fungi are filamentous in nature and grow by penetrating the wood with root-like filiaments (Hyphae). Fungi reproduce by spores, normally airborne and germinating on damp wood.

The growth cannot occur without the presence of oxygen and moisture in excess of saturation. Dry wood does not decay and fungi cannot grow on waterlogged or submerged wood because oxygen is excluded. The fungi are tolerant to variations in pH and temperature. pH values below 7.0 and temperatures between 88 and 105 F are most conducive to growth. On freezing, fungi becomes dormant while a temperature of 150 degrees for 30 minutes is required for killing.

Various species of fungi preferentially attack different constituents of wood. Some live on sugars and extractives. Most wood destroyers attack cellulose, leaving a dark crumbly residue, rich in lignin and known as brown rot. The fungi that destroy lignin produce "white pocket rot" reducing the wood to a stringy light colored mass.

Both brown and white rots have been found in cooling tower lumber with white rot the more prevalent and destructive. Brown rot has been found only at points where the wood is in contact with iron fastenings or where water dripping from iron strikes it. Brown rot is confined to a relatively small area while white rot will permeate an entire timber as well as the adjacent lumber. The infection is not confined to any particular type, make or part of a cooling tower.

Organisms causing brown rot include *Lenzites trabea, Poria menticula, Lentinus lepideus,* and others. White rot organisms have not been identified by names.

It is obvious that chemicals in the cooling water will not prevent decay because the decay occurs mostly in the sections of tower not regularly exposed to water. However it will minimize the possibility of infection.

Cooling towers are most effectively protected from fungi by treating the wood. In place, towers can be protected by first impregnating the wood by spraying with a strong copper sulfate solution, then with a sodium chromate solution. The toxic copper chromate precipitates within the body of the wood. This is known as the

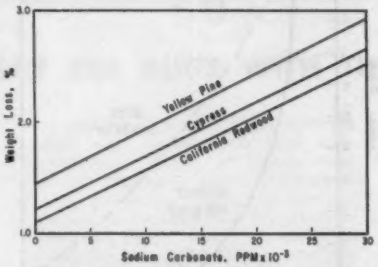

FIGURE 5—The deterioration of a cooling water tower is dependent on the concentration of alkaline salts in the circulating water. These data were taken after 60 days of immersion in sodium carbonate solution.

"double diffusion" method of treatment. Because copper salts are corrosive to steel, this combination is not popular. If a hot 20 percent solution of copper pentachlorophenate is substituted for the copper sulfate, the corrosion can be reduced.

Successful double diffusion treatment has been reported[12] by spraying first with a solution of 6 percent by weight zinc sulfate and 1 percent arsenous acid. The fans were run until the wood surface appeared dry. A 6 percent solution of sodium chromate was then sprayed and the tower allowed to dry. After the tower went back into normal service, the maximum concentrations of the chemicals found in the circulating water were 58.7 ppm zinc sulfate, 12 ppm arsenous acid, and 72.5 ppm sodium chromate.

After 24 days, lumber samples were analyzed and found to contain from 0.43 to 1.18 pounds of salt per cubic foot. After one years service the wood still contained from 0.48 to 0.92 pounds of salt per cubic foot.

A single diffusion treatment[1] is composed of:

Cupric hydroxide	58%
Arsenic trioxide	39%
Ammonia	3%
Acetic acid	trace

The salts are soluble in the presence of ammonia which later evaporates and precipitates them.

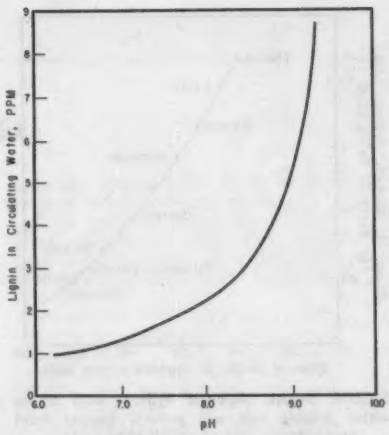

FIGURE 6—Maintaining the pH of the circulating water below 7.5 will minimize the transfer of the lignin from the wood to the water.

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TABLE 3
Lethal dosages for some organisms

ORGANISM	ppm			
	Trichlorophenate	Pentachlorophenate	Chlorine	Copper Sulfate
Aerobacter Cloacae	100	50		
Aerobacter Aerogenes	30	50		
Escherichia Coli	100	50		
Bacillus Subtilis	100	50		
Crenothrix			0.5	0.3
Chlorophyceae			0.7	0.5
Cyanophyceae			1.0	0.4
Diatomaceae			2.0	0.5

Polar Diagrams Speed Cooler-Condenser Design

No more trial and error calculations if you use this graphical method. A polar diagram is used to determine the gas-liquid interface conditions.

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THE DESIGN of a cooler-condenser by the method of Colburn and Hougen[1] requires the point to point calculation of the interface conditions, t_c and p_c. This calculation is carried out by trial and error solution of the equation,

$$h_o(t_c - t_w)\,dA = h_g(t_g - t_c)\,dA + k_g(p_v - p_c)\,\lambda\,dA = U(t_g - t_w)\,dA = dQ \quad (1)$$

For saturated gas-vapor mixtures, the relation between the gas temperature, t_g, and the cooling water temperature, t_w, can be derived from a simple heat balance, when the inlet and outlet conditions for the cooler-condenser are fixed.

The heat- and mass transfer coefficient, h_g and k_g, can be calculated from point to point by making use of one of the correlations proposed in the literature, for instance the equations given by Chilton and Colburn,[2]

$$h_g = \frac{j\,c\,G}{Pr^{2/3}} \quad (2)$$

$$k_g = \frac{j\,G\,M_v}{M_m\,p_{gf}\,Sc^{2/3}} \quad (3)$$

When a sufficient number of intermediate points have been calculated, the tube area, *A*, can be calculated by a graphical integration of the equation,

$$A = \int dA = \int \frac{dQ}{U(t_g - t_w)} \quad (4)$$

The graphical integration is carried out by plotting of Q against $1/U(t_g - t_w)$, delivering the integration curve. The area under the integration curve is then equal to the numerical value of the tube area required, in accordance with Equation 4. The area can be measured or calculated by standard methods.

The Colburn-Hougen method is generally considered as reliable but rather laborious and time consuming due to the trial and error computations required.

The author[3] has recently presented a graphical procedure for the solution of Equation 1. It was shown that Equation 1 can be brought in the form,

$$\frac{p_v - p_c}{t_c - t_B} = \frac{R_h + 1}{R_m} \quad (5)$$

where,

$$R_h = \frac{h_g}{h_o} \quad (6)$$

$$R_m = \frac{k_g \lambda}{h_o} \quad (7)$$

$$t_B = t_w + \frac{R_h}{R_h + 1} \cdot (t_g - t_w) \quad (8)$$

Equation 5 can be solved for t_c and p_c by a graphical method. In Figure 1, a saturation curve represents the relation between temperature and partial vapor pressure. Point *A* represents the point $t = t_w$, $p = p_v$, and point *B* represents $t = t_B$, $p = p_v$. If a straight line with a slope equal to $-(R_h + 1)/R_m$ is drawn through point *B*, the intersection of this line with the saturation curve will give point *C*, with the coordinates $t = t_c$, $p = p_c$.

It can be seen from Equation 3 that the numerical value of the mass transfer coefficient, k_g, depends on the logarithmic mean partial pressure of the non-condensing gas, p_{gf}. In case of low vapor concentrations, p_{gf} can be taken as approximately equal to the total pressure, *P*, and the graphical method described will be straight forward. In case of high vapor concentrations, p_{gf} must be estimated, for the computation of the mass transfer coefficient, k_g, and the ratio R_m. As a first approximation, p_{gf} is taken in such a way as to make $(P - p_v) < p_{gf} > (P - p_w)$. This will then result in approximate values for k_g, R_m, and the slope $-(R_h + 1)/R_m$. Consequently, in those cases the application of the graphical method

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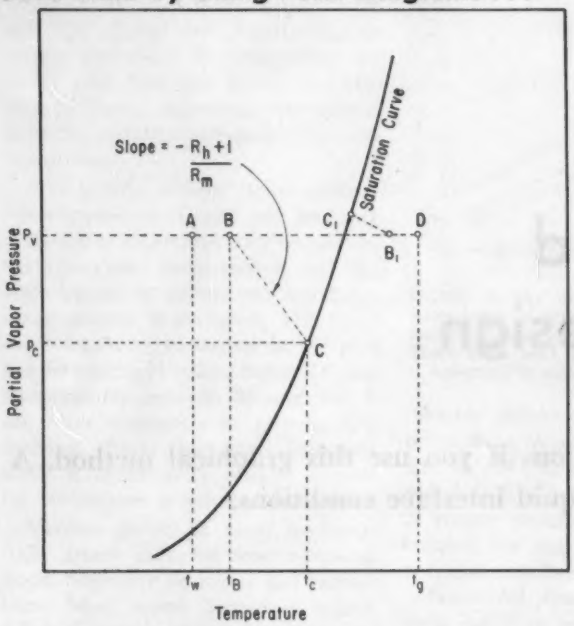

FIGURE 1—Graphical determination of interface conditions.

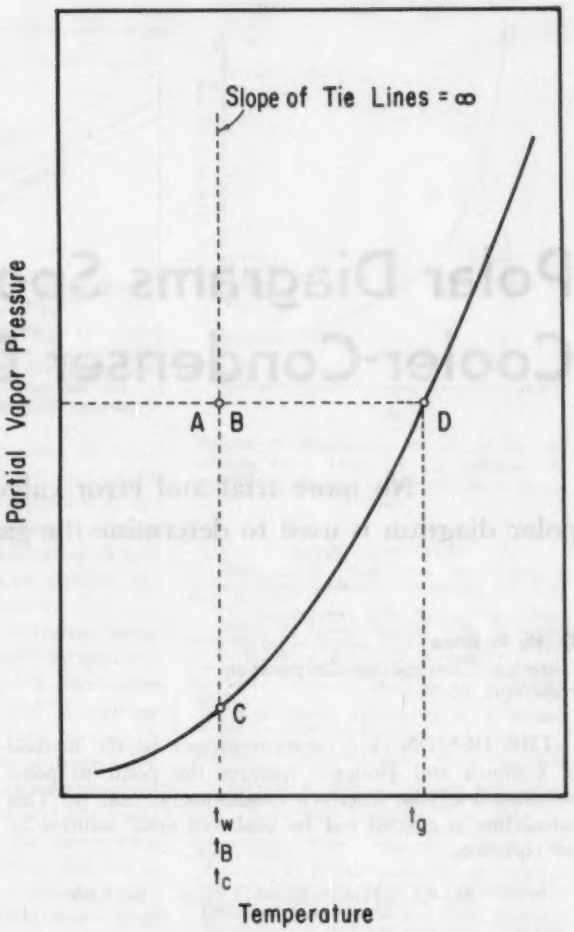

FIGURE 2—Polar diagram for $h_o = \infty$.

will give approximate values for the gas-liquid interface conditions, t_c and p_c.

Then, it will be necessary to check if the values for t_c and p_c satisfy the Equation 1. If the agreement is not satisfactorily for engineering calculations, an improved value for p_{gf} can be calculated from the value for p_c found graphically. This will also enable the calculation of an improved value for R_m, and for the slope of the tie lines,—$(R_h + 1)/R_m$, respectively. The graphical procedure can then be repeated by drawing a straight line with this slope through the same point *B*. Generally, one or two of those lines will give values for t_c and p_c that reasonably satisfy Equation 1.

The graphical procedure is valid only when condensation of part of the vapor actually occurs. Then, point *B* will be located at the left side of the saturation curve, see Figure 1, and $t_B < t_c$. When point *B* is located on the saturation curve, $t_B = t_c$, and this is the border case between condensation and no condensation.

In coolers for non-saturated gas-vapor mixtures, it is sometimes found that point *B* is located at the right side of the saturation curve, see point B_1 in Figure 1. Then, the application of the graphical procedure would deliver a point C_1, for which $p_c > p_v$, and $t_B > t_c$. Obviously, no condensation can take place. Therefore, the graphical procedure described above should not be applicable in this case. Also, the over-all heat transfer coefficient, U, can be directly calculated from $1/U = 1/h_o + 1/h_g$.

Recently, the author[4] has presented a complete design example, worked out for a cooler-condenser handling a saturated mixture of carbon dioxide and water vapor. All intermediate values for the gas-liquid interface conditions, t_c and p_c, were obtained by the graphical method described. The slopes of all the tie lines were calculated by assuming $p_{gf} = P - p_v$. It was found that the point to point values for $h_o(t_c - t_w)$ obtained in this way were nearly identical to $U\Delta t_{ov}$ as calculated by the Colburn-Hougen trial and error method. The deviations for the intermediate points were in the range between —0.3 and +2.3 percent, mostly within the accuracy of a graphical computation. The tube area for the cooler-condenser showed a deviation of only +0.5 percent as compared with the Colburn-Hougen method.

This result clearly demonstrates that the graphical procedure for the design of cooler-condensers may give accurate results without requiring trial and error computations. It is the purpose of this article to show a further development of the graphical procedure in which use is made of a polar diagram.

Polar Diagram—It has been observed that the tie lines through the reference points *B* intersect each other within a relatively small plane in a temperature-vapor pressure diagram. Also, it was found that the intersection of the two tie lines for the inlet and outlet condition can be used as a polar point for all the other tie lines, with a remarkable degree of accuracy in many cases. This will

give a polar diagram of the type shown in the Figures 4 and 6.

The use of the polar diagram for the design of cooler-condensers will permit the omission of the point to point calculation of the slope of the tie lines. All tie lines are then drawn through the polar point, *P*, and the reference points *B* which have coordinates $t = t_B$, $p = p_v$. The location of the polar point *P* can be obtained from an accurate determination of the reference point *B*, and the interface point *C* (coordinates $t = t_c$, $p = p_c$) for the inlet and outlet conditions of the cooler-condenser. The polar point *P* can then be established as the intersection of the two tie lines drawn through the points *B* and *C* in a temperature-partial vapor pressure diagram. Also, the location of the polar point can be calculated from the two equations for the slope of the tie lines for the terminals. This latter procedure is usually more accurate.

It is possible to show that for infinite values of the combined heat transfer coefficient for the cooling water, the tube wall, the condensate, and the scale deposits, h_o, the method is theoretically sound.

From the Equations 6, 7, and 8, it can be seen that for $h_o = \infty$, $R_h = 0$, $R_m = 0$, and $t_B = t_w$. Also, from Equation 5 follows that the slope of the tie lines,—$(R_h + 1)/R_m = \infty$. Thus, all tie lines are straight vertical lines through the points $t = t_w$, $p = p_v$, see Figure 2. Since all tie lines are vertical for $h_o = \infty$, the ordinate of the polar point, p_P, is equal to ∞. This case is encountered in scrubber-condensers if it is assumed that the resistance to heat transfer in the liquid is equal to zero.

Further, for $h_o = 0$, $R_h = \infty$, $R_m = \infty$, and $t_B = t_g$, while the slope of the tie lines,—$(R_h + 1)/R_m = 0$. Then, all the tie lines are straight horizontal lines through point *B*, see Figure 3. Consequently, the abscissa of the polar point, *P*, t_p, will be equal to $t_P = -\infty$. It will be evident, however, that the latter case has no practical interest, since the rate of total heat transfer would be zero.

Regardless whether the polar diagram has a theoretical basis for finite values of h_o, or not, its application for the design of cooler-condensers may be advantageous in a great many cases. It can be shown that the interface conditions determined by the application of the polar diagram are accurate enough for most engineering calculations of this type. This will be demonstrated later in two design examples.

It is also possible to check if the results obtained by the application of the polar diagram do satisfy Equation 1. When the agreement does not seem satisfactorily, the value found for p_c in the polar diagram can then be used for the calculation of an improved slope of the tie lines, by the application of the equations for p_{gf}, k_g, R_m, and Equation 5. Then another tie line with this slope can be drawn through the same point *B*. The intersection of this straight line with the saturation curve will then deliver improved values for t_c and p_c. More than one or two tie lines are seldom required.

The new design method has been tested by the comparison of two design examples with the Colburn-Hougen trial and error method, the deviations in total tube area as calculated for the two methods amounted to +0.2 percent, and —2.0 percent, respectively. Even better agreement can be obtained by dividing the cooler-condenser in two parts, and using a different polar point for each part.

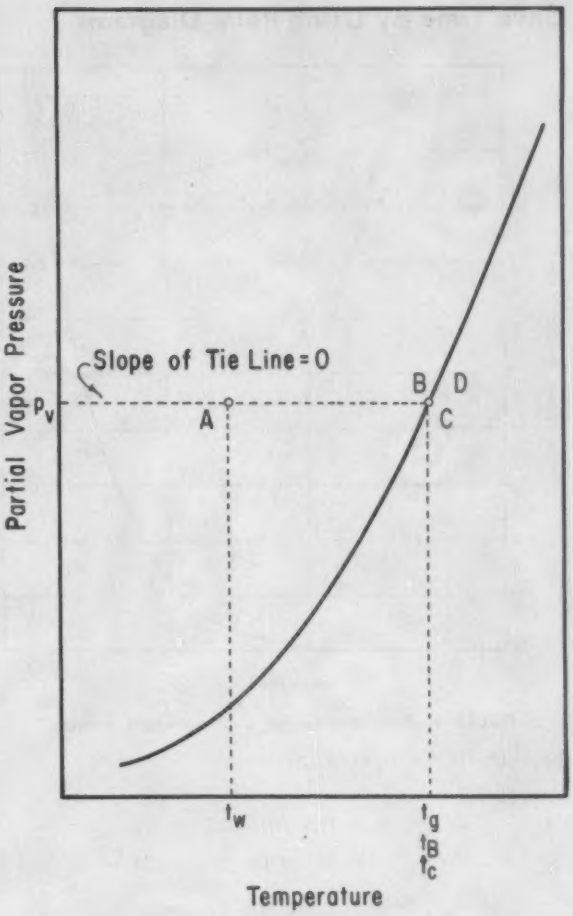

FIGURE 3—Polar diagram for $h_o = 0$.

It should be pointed out here, that the polar diagram can give limited help only if the combined heat transfer coefficient, h_o, varies greatly. In most practical cases, h_o can be taken as constant, however.

Example 1—Colburn and Hougen[1] have published complete design calculations for a shell and tube cooler-condenser handling 100 pounds moles per hour of a non-condensing gas (molecular weight 28), at 1 atmosphere pressure and saturated with water vapor at 95 C. The gas-vapor mixture is cooled to 40 C. at the shell side, and cooling water is heated from 25 C. to 60 C. at the tube side of the cooler-condenser. The condenser has 83 tubes 0.75 inch O.D., 0.62 inch I.D., and the total calculated tube surface required is equal to 695 square feet (outside area).

The application of the polar diagram for the solution of the same design problem involves the determination of the polar point, *P*, and the reference points *B*. The location of the polar point is determined from the inlet and outlet conditions, as follows:

At the gas inlet side, the gas film heat transfer coefficient, h_g, is equal to 34.5 P.c.u./hr. sq. ft. C., and the gas film mass transfer coefficient, k_g, is equal to $4.88/0.185 = 26.38$ lb.-moles/hr. sq. ft. atmosphere. Also, the combined heat transfer coefficient for all the other resistances, h_o, is

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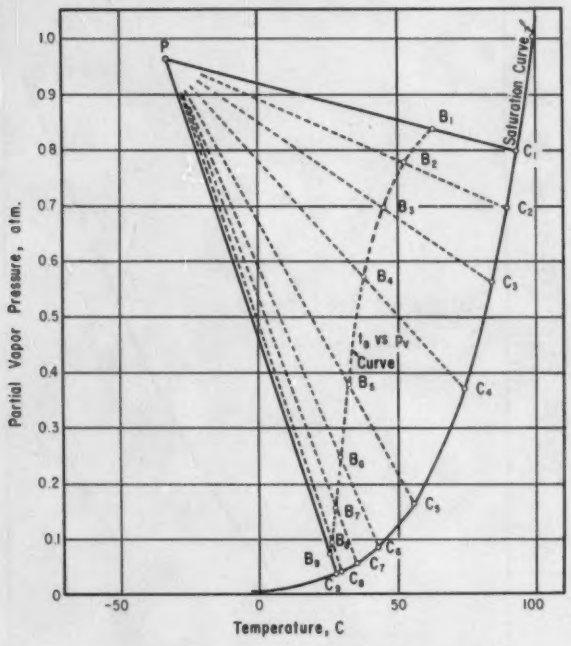

FIGURE 4—Polar diagram for Colburn-Hougen example.

equal to 310 P.c.u./hr. sq. ft. C.

Thus,

$$R_h = 34.5/310 = 0.1112$$

$$R_m = (26.38 \times 9760)/310 = 830$$

$$\frac{R_h + 1}{R_m} = \frac{1.1112}{830} = 0.001338$$

$$t_B = 60 + \frac{0.1112}{1.1112} \cdot 35.0 = 63.50\ C.$$

At the gas outlet side of the cooler-condenser, $h_g = 11.7$ P.c.u./hr. sq. ft. C., $k_g = 2.04$ lb. mole/hr. sq. ft. atmosphere, and $h_o = 310$ P.c.u./hr. sq. ft. C. Application of the Equations 6, 7, and 8 gives,

$$R_h = 11.7/310 = 0.03775$$

$$R_m = (2.04 \times 10{,}330)/310 = 67.9$$

$$\frac{R_h + 1}{R_m} = \frac{1.03775}{67.9} = 0.01528$$

$$t_B = 25 + 15 \cdot \frac{0.03775}{1.03775} = 25.55\ C.$$

The location of the polar point, *P*, is now found in a vapor-pressure-temperature diagram, see Figure 4, where the curve represents the saturation line. The points B_1 and B_9 represent the reference point for the inlet and outlet conditions, respectively. The reference point *B* has the coordinates $t = t_B$, $p = p_v$. Through the points B_1 and B_9 straight lines can be drawn with slopes equal to —0.001338 and —0.01528, respectively. These tie lines intersect each other in the polar point *P*, while the intersection with the saturation line delivers the points C_1 and C_9, respectively. The points C_1 and C_9 indicate the condition of the condensate at the gas-liquid interface for the inlet and the outlet of the cooler-condenser. The coordinates of these points are equal to $t = t_c$, $p = p_c$. In this example, the polar point *P* has the coordinates $t = -32.5$ C., $p = 0.9625$ atmosphere.

The determination of the gas-liquid interface conditions for the other intermediate points in the cooler-condenser can now be carried out with the polar diagram in a simple way. First, the reference temperature, t_B, is calculated from the point to point values for h_g, h_o, t_g, t_w, as reported in the original literature, see Table 1. These data enable the calculation of R_h and t_B by application of the Equations 6 and 8, see Table 1. The points $B_2 - B_8$ represent these intermediate points in Figure 4, and they have the coordinates $t = t_B$, $p = p_v$.

Next, straight tie lines through the polar point *P* and the reference points $B_2 - B_8$ are drawn in Figure 4, and these lines intersect the saturation curve in the points $C_2 - C_8$. The points $C_2 - C_8$ represent the interface conditions, t_c, p_c, of the intermediate points 2 — 8. How accurate the determination of t_c and p_c with the help of a polar diagram is, can be checked with Equation 1, or $h_o(t_c - t_w)$ should be equal to $h_g(t_g - t_c + k_g(p_v - p_c)\lambda$. Usually, when the saturation curve is rather steep in the range of the cooler-condenser, as in most industrial cooler-condensers, the value for $h_o(t_c - t_w)$ is more accurate than the value for $h_g(t_g - t_c) + k_g(p_v - p_c)\lambda$. This is due to the fact that a small deviation in t_c will result in a relatively large deviation of p_c from the correct value. In this example, the point to point values for $h_o(t_c - t_w)$ calculated from the t_c values derived from the polar diagram, have therefore been compared directly with the total heat flux, $U\Delta t_{ov}$, as given by Colburn and Hougen,[1] see Table 2. In the same table is also shown the percent

TABLE 1
Colburn-Hougen Example

POINT	h_g Pcu / Hr. Sq. Ft. C.	h_o Pcu / Hr. Sq. Ft. C.	t_g C.	t_w C.	R_h	t_B C	p_v Atm.
1	34.5	310	95	60.0	0.1112	63.5	0.835
2	27.3	310	93	49.7	0.0881	53.2	0.775
3	23.0	310	90	42.3	0.0742	45.6	0.695
4	18.0	310	85	35.8	0.0581	38.5	0.570
5	14.5	310	75	30.5	0.0468	32.5	0.378
6	12.5	310	65	28.0	0.0403	29.45	0.245
7	12.0	310	55	26.6	0.0387	27.65	0.156
8	11.8	310	45	25.4	0.0381	26.1	0.094
9	11.7	310	40	25.0	0.0378	25.55	0.073

TABLE 2
Polar Diagram Applied to Colburn-Hougen Example

POINT	t_c C.	p_c Atm.	$(t_c - t_w)$ C.	$h_o(t_c - t_w)$ Pcu / Hr. Sq. Ft.	$U\Delta t_{ov}$ Pcu / Hr. Sq. Ft.	Percent Deviation	10^{-3} Q Pcu/Hr.
1	93.6	0.795	33.6	10,400	10,400	0.00	5.39
2	90.0	0.6935	40.3	12,500	12,600	—0.80	3.79
3	84.6	0.560	42.3	13,100	13,070	+0.23	2.66
4	74.3	0.3685	38.5	11,930	11,500	+3.74	1.66
5	56.0	0.1625	25.5	7,900	7,370	+7.19	0.848
6	42.7	0.085	14.7	4,550	4,340	+4.84	0.453
7	35.1	0.055	8.5	2,630	2,510	+4.78	0.248
8	29.7	0.0405	4.3	1,332	1,335	—0.22	0.073
9	27.9	0.0365	2.9	898	905	—0.77	0.00

deviation between the two figures. It can be seen that the deviations range between —0.80 and +7.19 percent. However, the agreement appears to be sufficient for engineering calculations. This is confirmed by the calculation of the tube surface required for the cooler-condenser.

The tube surface required can be calculated by graphical integration of Equation 4. For this purpose, the reciprocal heat flux, $1/h_o(t_c - t_w)$, has been plotted against total heat transferred, Q, in Figure 5. The area under the integration curve so obtained is equal to the numerical value of the tube surface. The area under the integration curve of Figure 5, from the zero ordinate, has been calculated by multiplication of small increments of Q with the average incremental reciprocal heat flux, $1/h_o(t_c - t_w)_{av}$. In this way, a total area is obtained by addition of the incremental areas, and the total is equal to 691.9 square feet. The total tube surface calculated by Colburn and Hougen[1] is equal to 695 square feet, but if calculated in the same way by the addition of similar incremental areas, the result is 705.4 square feet.

It can thus be concluded that the relative deviation between the Colburn-Hougen trial and error method and the polar diagram method, amounts to not more than about —2.0 percent in this example. The agreement is sufficient for engineering calculations.

Example 2—In a design example for a cooler-condenser recently published by the author,[4] a saturated mixture of carbon dioxide and water vapor at 1 atmosphere and 203 F. was cooled to 95 F. The total flow of carbon dioxide was 7750 pounds per hour, at the outside of the tubes of a shell and tube cooler. The cooling liquid inside of the tubes was heated from 77 F. to 149 F. The cooler-condenser has 169 stainless steel tubes, 0.824 inch I.D. The total tube surface calculated by the Colburn-Hougen trial and error method is 4048 square feet.

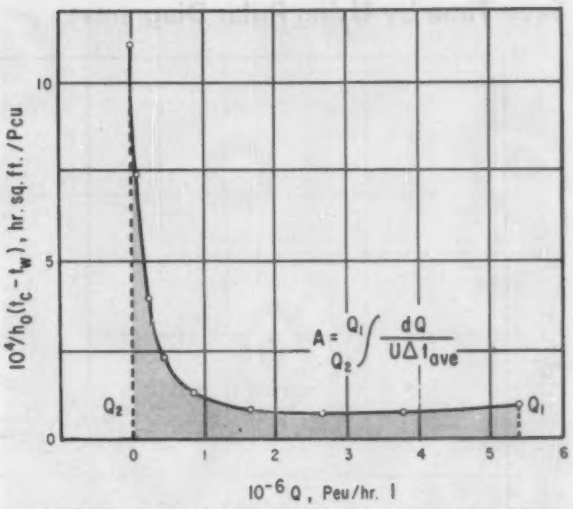

FIGURE 5—Graphical integration (Colburn-Hougen example).

If the polar diagram is used for the determination of the gas-liquid interface conditions, t_c and p_c, the procedure to follow involves the determination of the polar point, and the calculation of the reference temperature, t_B, for various intermediate points.

The polar point *P* is found from the inlet and outlet conditions of the cooler-condenser. Referring to the original publication, for the inlet, $t_B = 163.1$ F., $p_v = 0.8341$ atmosphere, and the interface conditions as calculated by the Colburn-Hougen trial and error method: $t_c = 202.4$ F., $p_c = 0.8238$ atmosphere.

At the outlet of the cooler-condenser, $t_B = 79.05$ F., $p_v = 0.0555$ atmosphere, $t_c = 84.3$ F., and $p_c = 0.0396$ atmosphere.

In Figure 6, the points B_1 and C_1 refer to the inlet

TABLE 3
Cooler-Condenser for Carbon Dioxide-Water Vapor Mixtures

POINT	t_B F.	p_v Atm.	t_w F.	q Btu/Lb.
1	163.1	0.8341	149.0	2407.23
2	156.9	0.8190	141.75	2168.62
3	151.5	0.8038	135.6	1966.84
4	142.75	0.7745	126.05	1652.60
5	136.05	0.7460	118.9	1417.39
6	125.85	0.6918	108.9	1088.87
7	118.65	0.6409	102.25	870.80
8	110.9	0.5705	95.7	654.09
9	96.95	0.3804	85.35	313.60
10	89.85	0.2468	81.15	175.63
11	85.3	0.1553	79.0	104.93
12	81.85	0.0946	77.75	64.44
13	79.05	0.0555	77.0	39.70

TABLE 4
Polar Diagram Design for Carbon Dioxide Cooler-Condenser

POINT	t_c F.	p_c Atm.	$h_o(t_c-t_w)$ Btu / Hr. Sq. Ft.	$U\Delta t_{ov}$ Btu / Hr. Sq. Ft.	Percent Deviation
1	202.4	0.8238	3,830	3,830	....
2	201.3	0.8040	4,275	4,270	+0.12
3	200.1	0.7875	4,630	4,640	—0.22
4	197.95	0.7515	5,160	5,150	+0.19
5	195.35	0.7135	5,490	5,510	—0.36
6	190.65	0.6450	5,870	5,895	—0.42
7	186.1	0.5820	6,015	6,025	—0.17
8	178.9	0.4935	5,975	5,975	0.00
9	153.75	0.2755	4,910	4,925	—0.30
10	130.2	0.1520	3,520	3,540	—0.57
11	110.5	0.0880	2,260	2,275	—0.66
12	95.2	0.0550	1,252	1,263	—0.87
13	84.3	0.0396	523	523	....

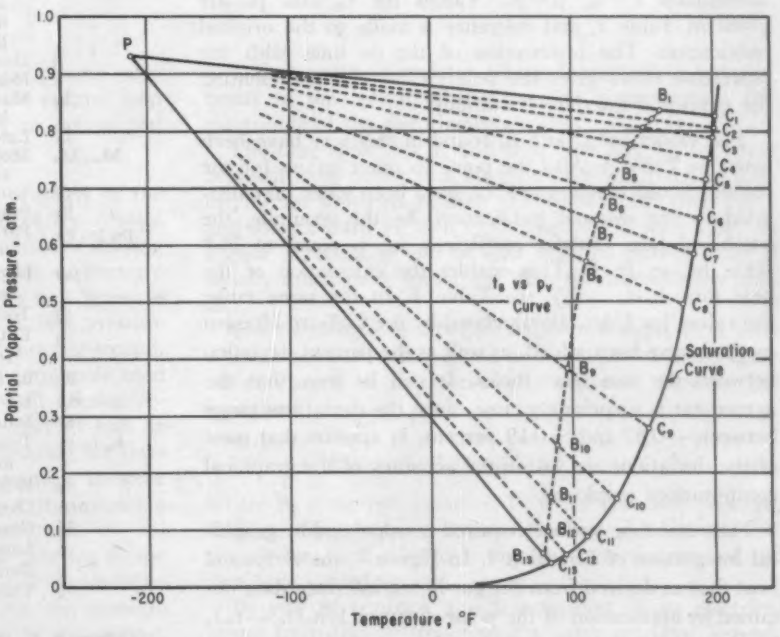

FIGURE 6—Polar diagram for CO_2-H_2O Cooler-Condenser.

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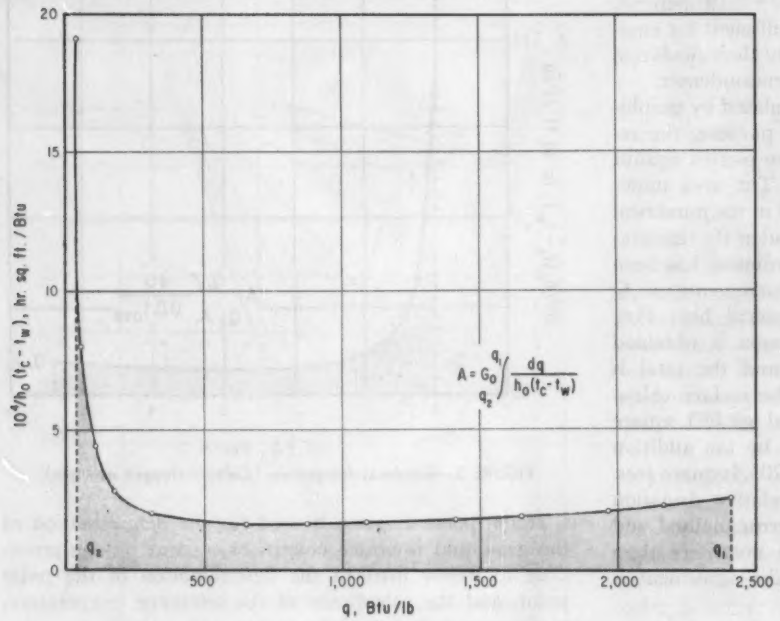

FIGURE 7—Graphical integration for CO_2-H_2O Cooler-Condenser.

conditions and the points B_{13} and C_{13} refer to the outlet condition. If straight lines are drawn through the points B_1 and C_1, and through B_{13} and C_{13}, respectively, the intersection of the two lines will give the polar point P. The coordinates of the polar point found in this way are, $t = -211.0$ F., $p = 0.9326$ atmosphere.

The gas-liquid interface conditions for all the other points can now be obtained by drawing straight tie lines through the polar point P and the reference points $B_2 - B_{12}$, respectively, see Figure 6. The points $B_2 - B_{12}$ have coordinates $t = t_B$, $p = p_v$. Values for t_B and p_v are given in Table 3, and reference is made to the original publication. The intersection of the tie lines with the saturation curve gives the points $C_2 - C_{12}$, representing the gas-liquid interface conditions.

The values for t_c and p_c found in this way have been listed in Table 4. Also the point to point values for the cooling liquid temperature, t_w, have been given, as calculated in the original publication. In this example, the combined heat transfer coefficient, h_o, is equal to 71.8 B.t.u./hr. sq. ft. F. This enables the calculation of the heat flux, $h_o(t_c - t_w)$, see Table 4. In the same table, the values for $U\Delta t_{ov}$ as calculated by the Colburn-Hougen method have been added, as well as the percent deviation between the two heat fluxes. It can be seen that the agreement is surprisingly close, since the deviations range between —0.87 and +0.19 percent. It appears that most of the deviations are within the accuracy of the graphical computations employed.

The total tube surface required is calculated by graphical integration of Equation 4. In Figure 7, the reciprocal heat flux as derived from the gas-liquid interface data obtained by application of the polar diagram $1/h_o(t_c - t_w)$, has been plotted against the total heat of the gas-vapor mixture, q, see Table 3. The area under the integration curve from the zero ordinate is then equal to the tube surface required divided by the total flow rate of the non-condensing gas, A/G_o. The area has been calculated by multiplication of small increments of the total heat, q, by the average incremental reciprocal heat flux, and addition of the surface increments so obtained. This gives $A/G_o = 0.5234$, or $A = 0.5234 \times 7750 = 4056$ square feet, against 4048 found by application of the Colburn-Hougen trial and error method. This represents a deviation of +0.2 percent only.

Summary—A new method for the design of cooler-condensers for gas-vapor mixtures has been presented. The tedious and time consuming trial and error computations of the Colburn-Hougen design method are replaced by a graphical procedure and the application of a polar diagram, for the determination of the gas-liquid interface conditions.

The polar diagram is applied to two design examples of cooler-condensers. The deviations of the total calculated tube surface, as compared with the Colburn-Hougen method are +0.2 percent, and —2.0 percent, respectively.

NOMENCLATURE

A	Cooler-condenser tube surface, sq. ft.
c	Heat capacity at constant pressure of gas-vapor mixture, Btu/lb. F.
D	Diffusion coefficient, sq. ft./hr.
G	Mass velocity of gas-vapor mixture, lb./hr. sq. ft.
G_o	Flow rate of non-condensing gas, lb./hr.
h_g, h_o	Heat transfer coefficient at the gas side, and heat transfer coefficient through all the other resistances, including cooling water, dirt and scale films, tube wall, and condensate, respectively, Btu/hr. sq. ft. F.
j	Heat transfer factor, dimensionless.
k	Heat conductivity, Btu/hr. ft. F.
k_g	Mass transfer coefficient at the gas side, lb./hr. sq. ft. atm.
L_v	Latent heat of condensation, Btu/lb. mol.
M_m, M_v	Molecular weight of gas-vapor mixture, and of vapor, respectively, lb./lb. mol.
P	Total pressure, atm.
Pr	Prandtl number, $c\mu/k$, dimensionless.
p_c, p_v, p_w	Partial vapor pressure of condensate, gas-vapor mixture, and cooling water, respectively, atm.
p_{gf}	Logarithmic mean pressure of the non-condensing gases in the gas film, atm.
Q	Total heat transferred, Btu/hr.
q	Enthalpy of gas vapor mixture, Btu/lb. of vapor free gas.
R_h	h_g/h_o, dimensionless.
R_m	$k_g\lambda/h_o$, F./atm.
Sc	Schmidt number, $\mu/\rho D$, dimensionless.
t_c, t_g, t_w	Temperature of condensate, gas-vapor mixture, and cooling water, respectively, F.
t_B	Reference temperature, see equation 8, F.
Δt_{ov}	Over-all temperature differential, $t_g - t_w$, F.
U	Over-all heat transfer coefficient, Btu/hr. sq. ft. F.
λ	Latent heat of condensation, Btu/lb.
ρ	Density, lb./cu. ft.
μ	Viscosity, lb./hr. ft.

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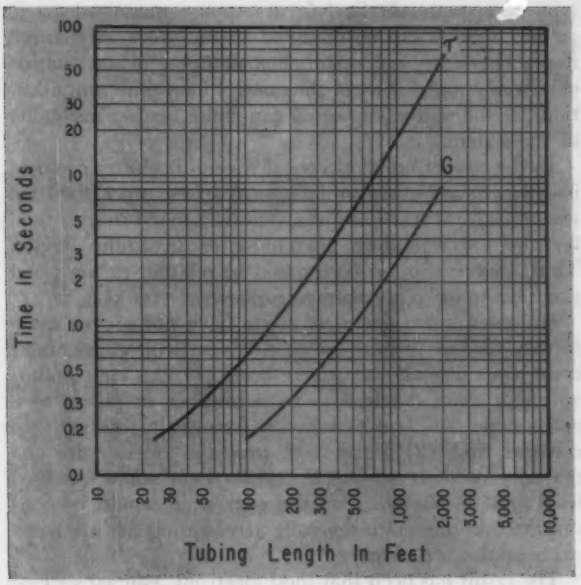

FIGURE 50—Long tubing tends to smooth out pressure changes. The effect may be represented by a first order time delay equation. Here are the constants for the equation when the tubing is 0.188 inches I.D.

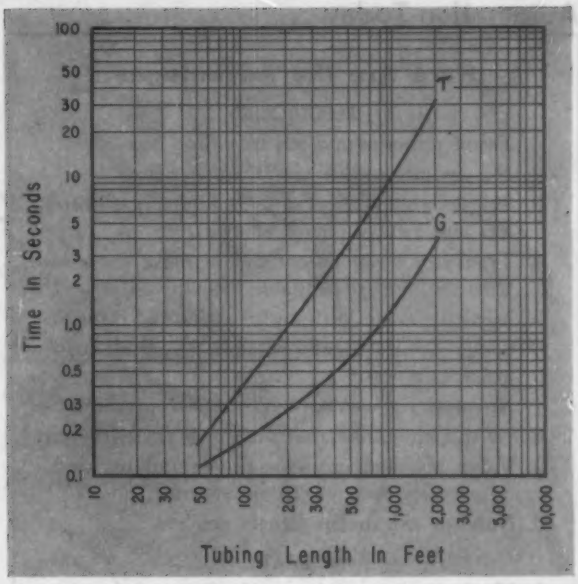

FIGURE 51—These constants apply to a first order time delay equation when the tubing is 0.385 inches I.D. These data were obtained by terminating the tubing in a bellows and using an upset to 15 psi from three psi infinite source.

Automation Today—Part 8

Each component of a control loop should be examined. Here is a look at some of the errors and delays caused by the control valve or other final control element.

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LAGS AND DELAYS vital to accurate process control which occur in the actuating side of the control loop can be specified as (a) transmission lags or delays and (b) actuator delays.

The transmission lag is a particular property of the pneumatic type control system. Actuation of the control valve in such a system is caused by the controller varying the air pressure to the valve. A change in this air pressure is propagated through the connecting pipes as a pressure pulse. In open air, this pulse would travel as a pressure wave at the speed of sound or about 1100 feet per second. However, within a pipe of the size of the commonly used air pipes in a pneumatic control system wall friction reduces the speed of propagation to the order of half or less of its open air value.[2] Since the connecting air lines between the control panels and valve actuators in some plants may be several hundred feet long, a true time lag of up to several seconds is immediately indicated.

In addition to the presence of the true time lag in the connecting lines, turbulence and the effect of the velocity gradient in the pipe tends to smooth out the pressure differential involved in the correction being transmitted. This smoothing out can usually be considered equivalent to a first order time delay whose magnitude is proportional to the length of the line, its diameter and the magnitude of the disturbance applied.

The time constants, τ, and true time lags, G, for some representative connecting air pipe lines are given in Figure 50, for standard ¼ inch O.D. line (0.188 inch I.D.) and for standard ⅜ inch O.D. line (0.305 inch I.D.) in Figure 51. Thus, it can be seen that the mixing delay is usually much more important than the transmission time lag.

The resulting over-all equation for the response of such a line is similar to that given as Equation 15 and Figure 13 of Part 2 of this series and repeated here as the equation:

$$\frac{P_2}{P_1} = \frac{e^{-pG}}{\tau p + 1}, \qquad (1)$$

where P_2 is the exit pressure, P_1 is the entrance pressure, G is the time required for the pressure pulse to traverse the air line, and τ is the equivalent time constant of the line as indicated above.

By way of contrast, the transmission of an electrical signal from the controller to the valve actuator is practically instantaneous. However, a completely electrical

Automation Today . . .

Here Are the Advantages

ELECTRONIC

1. Faster response and less true time lags.
2. No separate source of activating power.
3. Simpler connection between Samplers, Controllers and Final Control Elements.
4. Transistor development should make these systems the most dependable available.
5. Miniaturization easier with electronic elements.
6. Closer control usually possible, i.e., dead spaces are usually less.
7. No need for special cold weather precautions.
8. No dynamic unbalance such as is caused by air.
9. Valve positioning under system failure conditions easier with electronic systems.
10. Noise or extraneous signals are less.

PNEUMATIC

1. Much simpler and cheaper final control elements.
2. Maintenance easier with present personnel.
3. No explosion hazard.
4. Probably more dependable at present.

system has other drawbacks which are more serious, as will be brought out in the succeeding discussion.

Actuator delay exists when the change in pneumatic system pressure propagated from the controller actuates an air motor or diaphragm which moves the valve stem or other mechanism necessary to achieve the required correction to the process. Since the air chamber of the motor is of some finite size; the usual air line is quite small; and sufficient air must be supplied to overcome the resistance of the motor spring; the motor has an appreciable time constant.

Table 1 gives some typical time constants for such pneumatic valve motors.[2] A poor choice of an air line-valve combination might therefore give us a time delay almost hopelessly large in terms of good control. Time constants for corresponding hydraulic components are somewhat shorter than for pneumatic but still longer than the corresponding electrical components.

In most cases a pneumatically operated valve is represented by an "underdamped" second order equation. This is the expression represented by Equation 48 and Figure 32 of Part 5 which is repeated as the following equation:

$$\frac{P_2}{P_1} = \frac{1}{\tau^2 p^2 + \delta p + 1}, \qquad (2)$$

where $\delta \neq 2\tau$ and τ is the constant mentioned previously. As is shown by the figure and by the discussion of this

TABLE 1
Some Typical Time Constants for Pneumatic Valve Motors

Air Volume of Motor Air Chamber (3 psig)	DIAMETER OF AIR LINE	
	Standard ¼ In. O.D.	Standard ⅜ In. O.D.
25 Cubic Inches	3 Seconds	½ Second
105 Cubic Inches	14 Seconds	2 Seconds
200 Cubic Inches	50 Seconds	4 Seconds

type of response in Part 5, a response magnitude ratio greater than 1 can be obtained in the valve mechanism itself. Therefore, unless sufficient damping or attenuation occurs in another part of the control loop this "amplification" of the correction signal can cause further instability in the system.

In the case of an all electrical system this latter problem is still with us but, to a much lesser extent since the time constants for a servo motor are usually much shorter than for the corresponding pneumatic or hydraulic device. Thus, they can often be ignored in relation to the usual time constants of a chemical process.

However, servo operated valves have not proven satisfactory for the process use as a general rule. The major complaints against them have been (1) the servo motor and gear train required to be equivalent in power to a given pneumatic valve motor is frequently too costly to consider and (2) since most processes operate for the majority of their service life at or near some specified level most of the wear on the gear train would be concentrated at one point severally accelerating the mechanical breakdown problem.

The result has been that most electronic control systems developed to date terminate in a pneumatic or hydraulically operated valve.[1] That is, the electrical correction signal is used only to actuate a pilot valve which in turn regulates the air or hydraulic pressure input to the main valve and thus controls the process. We are, therefore, still faced with the long time constants of the valve mechanisms and the necessity for supplying air or hydraulic pressure as before. Our only gain is the elimination of long pneumatic lines with their inherent time constants and the possibility of stoppages in these lines. There is thus considerable activity underway in an effort to develop a suitable all electrical system which could do away completely with the problems associated with supplying air or hydraulic pressure to complete control systems or to valve mechanisms alone.

Electronic vs. Pneumatic Control

The accompanying box summarizes the main points of discussion in the consideration of electronic versus pneumatic or hydraulic control.[1,2,3,4]

Study of these points shows that, after the period of development which is needed to perfect a cheaper and more durable final control element, and a greater application of transistors to electronic controller circuits in order to improve their reliability, electronic control should be the universally applied method for all new installations. At present, however, their marginal superiority does not justify their greater expense for replacement items in comparison with pneumatic for installations which are already equipped with instrument air systems.

SYMBOLS USED

e — base of the Naperian logarithms
G — true time lag
P — pressure
p — the differential operator
δ — (delta), damping coefficient
τ — (tau), time constant

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Part 9 will appear in an early issue of PETROLEUM REFINER

Save time . . .

Physical Properties by Nomogram

All on one nomogram:

- Gravity
- UOP K Factor
- C/H Ratio
- Heat of Combustion
- Aniline Point
- Critical Pressure
- Molecular Weight
- Boiling Point

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A RECENT ARTICLE by the author in PETROLEUM REFINER[14] illustrates the use of nomograms for correlation and presentation of experimental data. Many of the properties of petroleum fractions can be correlated by use of two definitive properties. Smith and Watson[10] defined several different average boiling points for use as definitive properties and applied them to the correlation of certain physical properties of hydrocarbons. The "mean" average boiling point, as defined by Smith and Watson, is used in this article as one of the definitive properties. Specific gravity is the other.

The ASTM distillation of a petroleum fraction shows the atmospheric boiling points at which 10, 30, 50, 70, and 90 volume percents are distilled over. The arithmetic average of these five temperatures is the volumetric average boiling point:

$$t_v, °F = \frac{\text{ASTM } 10 + 30 + 50 + 70 + 90 \text{ percent points, } °F}{5} \quad (1)$$

This may be converted to the mean average boiling point by adding or subtracting a correction given in the article by Smith and Watson.[10]

The mean average boiling point also may be calculated by the following equation:

$$t_m, °F = t_v + 2 - \left(\frac{\text{ASTM } 90\% \text{ pt.} - 10\% \text{ pt., } °F}{170 + (0.075)\ (t_v)} + 1.5\right)^3 \quad (2)$$

For narrow boiling fractions the mean average boiling point is equal to the 50 percent point.

Carbon to Hydrogen Ratio of Fuel Oil—The weight ratio of carbon to hydrogen is graduated on the same scale stem as is the heat of combustion. The average deviation from the data given in articles by Mair and Schicktanz,[7] Farragher, et al[2] and certain unpublished data is about 2 percent.

Gross Heat of Combustion of Fuel Oil—The scale graduated with gross heat of combustion is for fuel oil on a water, sulfur, nitrogen and ash free basis. The presence of these constituents reduces the gross heating value as indicated by the following equation:

$$Q_g = \left[\begin{matrix}\text{Value from}\\ \text{Nomogram}\end{matrix}\right]\left[\frac{100 - \text{Wt\% } H_2O, \text{ S, } N_2 \text{ \& Ash}}{100} + (40)\ (\text{Wt\% S})\right] \quad (3)$$

The net heat of combustion may be obtained as follows:

$$Q_n = Q_g - \frac{8300}{\text{C/H wt ratio}} - (10)\ (\text{wt\% } H_2O) \quad (4)$$

The deviation of the nomogram from experimental data on heat of combustion is less than 1 percent.

U.O.P. Characterization Factor, K—A straight line may be drawn through a log-log plot of the specific gravity and atmospheric boiling point of a homologous series of hydrocarbons. The lines representing various homologous series have essentially the equal slopes of about ⅓. Watson and Nelson[12] introduced this correlation as a means of characterization of molecular structure of hydrocarbons. The equation of the relationship is:

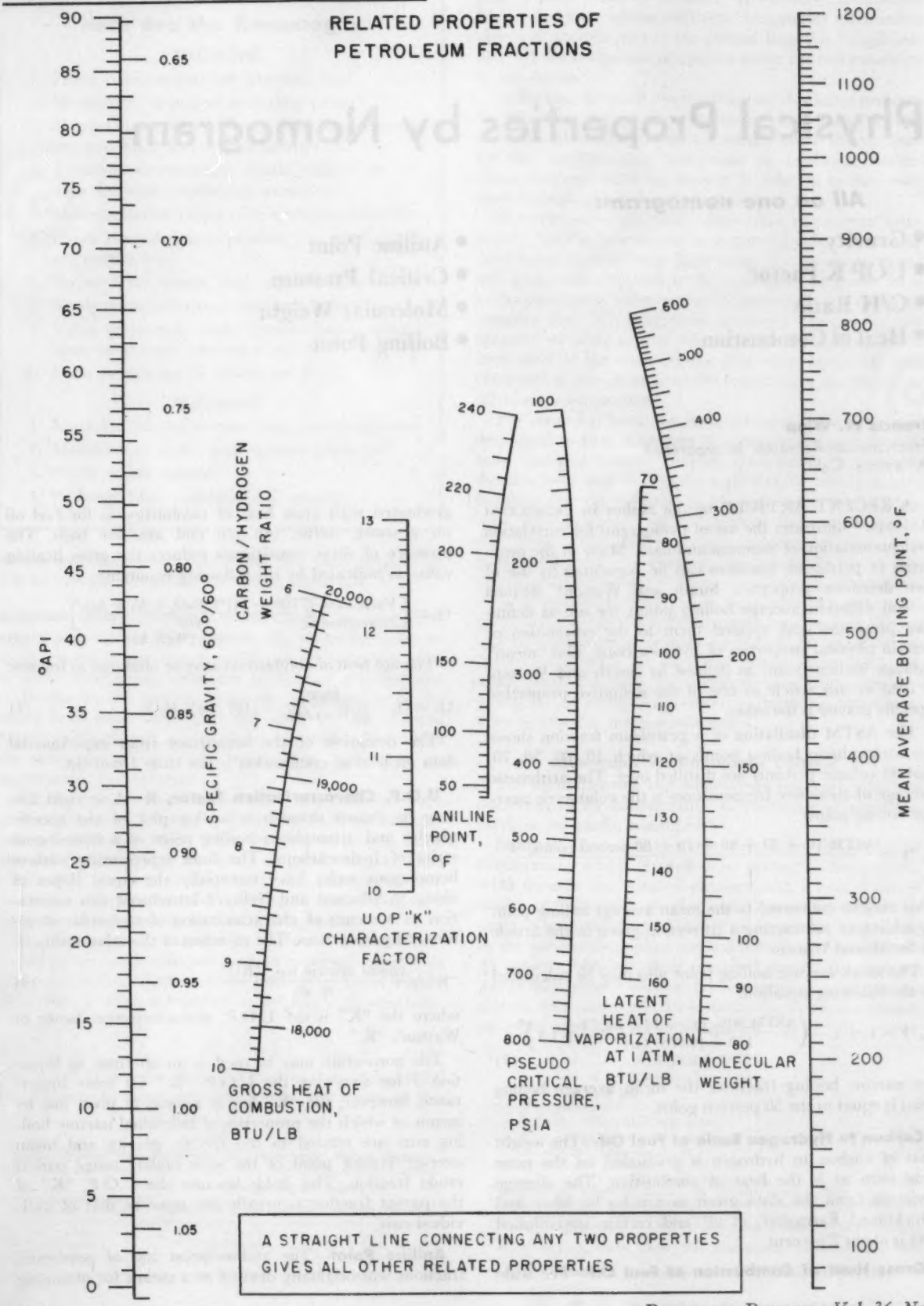
$$\text{"K"} = \frac{(\text{mean average b.p., } °R)^{1/3}}{\text{sp. gr.}} \quad (5)$$

where the "K" is the U.O.P. characterization factor or Watson's "K."

The nomogram may be used as an alternate to Equation 5 for obtaining the U.O.P. "K." Of more importance, however, the "K" line is a locus or pivot line by means of which the properties of individual narrow boiling cuts are related to the specific gravity and mean average boiling point of the wide boiling range parent crude fraction. This holds because the U.O.P. "K" of the parent fraction is usually the same as that of individual cuts.

Aniline Point—The aniline point test of petroleum fractions was originally devised as a means for obtaining

Physical Properties by Nomogram . . .



an indication of molecular structure. It will be noted that the aniline point scale and the U.O.P "K" scale on the nomogram are adjacent. Because the two lines are in nearly the same position on the nomogram the aniline point is a moderately good index of molecular structure. The U.O.P. "K" gives a better indication, however.

The aniline point scale shown on the nomogram was developed from data on about 150 samples. The average deviation is 5 F. for the samples tabulated by Cauley and Delgass[1] and 10 F. for those tabulated by Watson, et al.[11]

Pseudo Critical Pressure—It has long been recognized that the critical pressure of a mixture may be much greater than the critical pressure of a pure component having the same definitive properties. Ordinarily, the critical pressure of a mixture is greater than that of any component in it.

For problems involving the theorem of corresponding states, the use of true critical properties of mixtures leads to erroneous results. Kay[5] introduced the concept of the pseudo-critical point and defined it as that temperature and pressure which produce the same reduced compressibility factor correlation for mixtures as for pure components.

The data used in the construction of the pseudo critical pressure scale on the nomogram were taken from an article by Smith and Watson.[10] The average deviation is about 5 percent for the mixtures tabulated in Smith and Watson's article.

Latent Heat of Vaporization—Kistiakowsky[6] developed a theoretical equation for calculating latent heats of vaporization based on the third law of thermodynamics.

$$\Delta H = (7.58\ T_b + 4.56\ T_b \log T_b)/M \qquad (6)$$

Watson[13] found this equation to hold well for non-polar liquids. The nomogram gives values which are about 1.5 percent higher than those from the Kistiakowsky equation. The average deviation is less than 4 percent for hydrocarbons tabulated in API Project 44.

Molecular Weight—One of the physical properties most frequently used in process calculations is molecular weight. The average molecular weight of several petroleum fractions determined experimentally by Roess[9] and Kay[5] have an average deviation of less than one percent from nomographic values. The data of Fenske and McCluer,[3] FitzSimons & Thiele,[4] Mills et al[8] and certain other data indicate the average deviation is about 3 percent.

Application of Nomogram—Normally the nomogram is used by connecting any two known properties of a petroleum fraction with a straight edge or hairline reader. The other properties are then read at the intersections of the edge with the remaining scales. For example, the properties corresponding to a fraction having a mean average boiling point of 450 F. and an API gravity of 35 are:

Molecular weight, = 180
Latent heat of vaporization = 109 Btu/lb
Pseudo critical pressure = 330 psia
Aniline point = 124 F.
U.O.P. "K" = 11.4
Gross heat of combustion = 19,350 Btu/lb
Carbon to hydrogen weight ratio = 6.82.

Frequently, the characterization factors of individual narrow boiling cuts are the same as that of the parent wide boiling range crude fraction. In this event, the nomogram serves another very useful purpose. The properties of the individual cuts may be determined from their mid-boiling points and the U.O.P. "K" of the parent oil. For example, the "K" of a wide boiling fraction is 11.4 and the molecular weight and specific gravity are wanted for 100 F. cuts boiling between: (1) 300 and 400 F. (2) 400 and 500 F.; and (3) 500 and 600 F. The corresponding mid-boiling points are 350, 450 and 550 F. The specific gravity and molecular weight are respectively; (1), 0.816 and 140; (2), 0.85 and 180; and (3), 0.88 and 226.

NOMENCLATURE

C/H = carbon to hydrogen weight ratio
ΔH = latent heat of vaporization at one atmosphere pressure, Btu/lb.
"K" = U.O.P. characterization factor
M = molecular weight
Q_g = gross heat of combustion, Btu/lb
Q_n = net heat of combustion, Btu/lb
S = sulfur
T_b = atmospheric boiling point, F.
t_m = mean average boiling point, F.
t_v = volumetric average boiling point, F.

ACKNOWLEDGMENT

The original version of this nomogram was developed while the author was employed by Socony Mobil Oil Company. Permission to publish the correlation is gratefully acknowledged.

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About the Author

FRANCIS W. WINN is a name familiar to PETROLEUM REFINER readers. In the past year he has contributed a number of excellent articles, of which his recent series on nomograms was typical. As technical director for Fractionation Research, Inc., Winn is in charge of the Alhambra, Calif., concern's research program. A chemical engineering graduate of the University of Oklahoma, he joined the company in 1951, following an assignment as chief engineer with Catalytic Construction Corp. He also has been associated with a number of major oil companies and one time served the Petroleum Administration for War.

Diesel Fuel Survey Shows Product Quality

A NATIONAL SURVEY on diesel fuel blends produced in 1956 shows a small but continued trend to lighter and more narrow cuts. When broken down into geographical regions, this trend is not uniformly reflected. Tables below show the average properties of ASTM Grades 1-D and 2-D blends sampled in 1956.

Compared with 1955, both grades have a lower 90 percent point. Grade 2-D also has a lower 10 percent point. Cetane numbers for these two grades did not change significantly from 1955. These average data were released by the Bureau of Mines in a complete report, "National Annual Diesel Fuel Survey 1956" (Information Circular 7776). This survey is compiled annually under a cooperative agreement with API.

Sales of diesel fuel in the U. S. during the reported year and a half have increased greatly. In 1955 over 174 million barrels were sold. Railroads were the biggest users, consuming 46 percent or 80 million barrels. Trucks, buses, tractors and heavy moving equipment consumed 25½ percent. Other users: vessels (12 percent), industry (9½), military (4½), power plants (2) and oil companies (½). Daily deliveries of diesel from refineries averaged over 16,750 barrels during the first six months of 1956 compared with 15,250 barrels during the corresponding 1955 period.

In this survey, 329 samples of diesel fuel are represented. The fuels were manufactured by 49 refining companies in 112 refineries (large and small) throughout the country. The data are divided into three groups according to grade of diesel fuel (two shown here), and each group is subdivided into five geographical areas. Samples were typical of their production and were analyzed by the manufacturers using standard methods of tests.

TABLE 1—Grade 1-D Diesel Fuel: These Properties Were Typical for 1956

Geographic Distribution of Diesel Fuels	ASTM D975 Requirements			Eastern Region			Southern Region			Central Region			Rocky Mountain Region			Western Region		
TEST	Method	Min.	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.
Gravity, °API	D287	.....	.....	28.0	40.5	47.6	32.4	40.1	44.5	28.0	39.6	45.6	33.8	40.4	45.4	36.5	40.8	44.2
Flash point, P-M closed tester, °F.	D93	100	.....	126	.....	210	126	.....	186	122	.....	215	122	.....	212	134	.....	188
Color:																		
ASTM Union colorimeter	D155	.....	.....	<1	.....	2½	<1	.....	2	<1	.....	3	<1	.....	1½	<1	.....	1½
Saybolt chromometer	D156	.....	.....	+30	.....	−14	+30	.....	−14	+30	.....	−14	+30	....	+3	+30	.....	+3
Viscosity at 100° F.:																		
Kinematic, centistokes	D445	1.4	.....	< 1.35	2.11	3.44	1.50	2.06	3.36	1.4	2.22	3.79	1.4	2.13	3.02	1.46	1.91	2.80
Saybolt Universal, seconds	D88	.....	.....	30.0	33.0	37.5	.....	32.8	37.2	31.2	33.4	38.5	.....	33.1	36.1	.....	32.3	35.4
Cloud test, °F.	D97	.....	.....	−60	.....	22	−55	.....	5	−60	.....	30	−54	.....	20	−54	.....	−3
Pour point, do	D97	.....	.....	−70	.....	15	−55	.....	0	−70	.....	10	−55	.....	5	−60	.....	−15
Sulfur content, Wt. percent	D129	.....	0.50	0.020	0.142	0.75	0.02	0.090	0.26	0.014	0.184	0.68	0.01	0.226	0.780	0.008	0.184	.60
Aniline point, °F.	D611	.....	.....	112.6	150.2	172	134.4	149.7	164	116.3	149.0	194.8	134	149.3	163	132	146.9	163
Ramsbottom carbon residue on 10 percent residuum, percent	D524	.....	0.15	0.00	0.076	0.19	0.00	0.070	0.15	0.02	<0.085	0.21	0.00	<0.067	0.12	0.02	0.069	0.10
Ash, do	D482	.....	0.01	0.000	0.001	0.005	0.000	0.001	0.005	0.000	0.001	0.004	0.000	0.000	0.004	0.000	0.002	0.009
Cetane number	D613	40	.....	36	51.3	60	43.8	50.3	58	36	50.5	58	43.8	50.2	57.7	43	48.6	52
Distillation test, on volume recovered basis:	D86																	
Initial boiling point, °F.		.....	.....	322	364	442	330	360	418	310	366	456	310	365	451	320	354	411
10 percent		.....	.....	360	408	484	369	407	460	348	414	507	348	410	495	372	401	458
50 percent		.....	.....	412	460	526	412	458	520	376	469	543	376	458	527	412	447	508
90 percent		.....	.....	456	524	586	460	519	586	437	533	592	437	520	583	470	507	570
End point		.....	625	478	567	625	497	562	624	500	575	624	499	564	625	509	552	613

TABLE 2—Grade 2-D Diesel Fuel—1956

Geographic Distribution of Diesel Fuels	ASTM D975 Requirements			Eastern Region			Southern Region			Central Region			Rocky Mountain Region			Western Region		
TEST	Method	Min.	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.
Gravity, °API	D287	.....	.....	29.4	36.8	45.0	28.6	35.8	40.1	28.6	35.9	41.7	28.6	35.4	39.8	26.9	33.5	39.8
Flash point, P-M closed tester, °F.	D93	125	.....	138	.....	215	140	.....	204	143	.....	215	143	.....	200	154	.....	230
Color, ASTM Union colorimeter	D155	.....	.....	<1	.....	3	<1	.....	3½	<1	.....	5	<1	.....	5	<1	.....	4
Viscosity at 100 °F.:																		
Kinematic, centistokes	D445	1.8	5.8	2.07	2.89	3.95	2.35	2.86	3.95	2.07	2.87	4.58	2.11	3.09	4.58	2.11	3.30	4.3
Saybolt Universal, seconds	D88	32.0	45	32.9	35.0	39.0	33.9	35.6	39	32.9	35.6	41.0	33.0	36.3	41.0	33.0	37.0	40
Cloud test, °F.	D97	....	....	<−10	....	20	−50	.....	25	−50	.....	25	−18	.....	25	−18	.....	26
Pour point, do	D97	.....	.....	−25	.....	15	−90	.....	15	−90	.....	15	−25	.....	20	−25	.....	25
Sulfur content, Wt. percent	D129	.....	1.0	0.06	0.273	0.70	0.07	0.312	0.80	0.07	0.285	0.80	0.065	0.480	1.06	0.130	0.523	1.00
Aniline point, °F.	D611	.....	.....	127	150.4	178	129.0	150.6	170	118.7	148.6	170	121	146.9	166.6	112.8	143.0	162
Ramsbottom carbon residue on 10 percent residuum, percent	D524	.....	0.35	0.022	0.106	0.31	0.04	0.112	0.21	0.03	0.100	0.220	0.04	0.083	0.145	0.06	0.112	0.35
Ash, do	D482	.....	0.02	0.000	0.001	0.005	0.000	0.001	0.005	0.000	0.001	0.010	0.000	0.002	0.010	0.000	0.001	0.008
Cetane number	D613	40	.....	40.7	50.3	63.0	40	50.1	58	34.3	49.5	59.0	37.6	49.0	56.3	32	45.7	52.4
Distillation test, on volume recovered basis:	D158																	
Initial boiling point, °F.		.....	.....	312	369	442	312	374	440	326	375	442	334	386	430	342	387	460
10 percent		.....	.....	372	431	494	390	440	500	372	438	500	394	447	503	408	455	490
50 percent		.....	.....	440	502	550	472	511	580	457	509	580	460	513	560	469	522	560
90 percent		.....	675	530	587	654	558	589	632	542	590	632	562	596	635	552	606	650
End point		.....	.....	626	645	710	626	644	684	626	645	684	628	654	699	628	668	715

Beam Deflection . . .

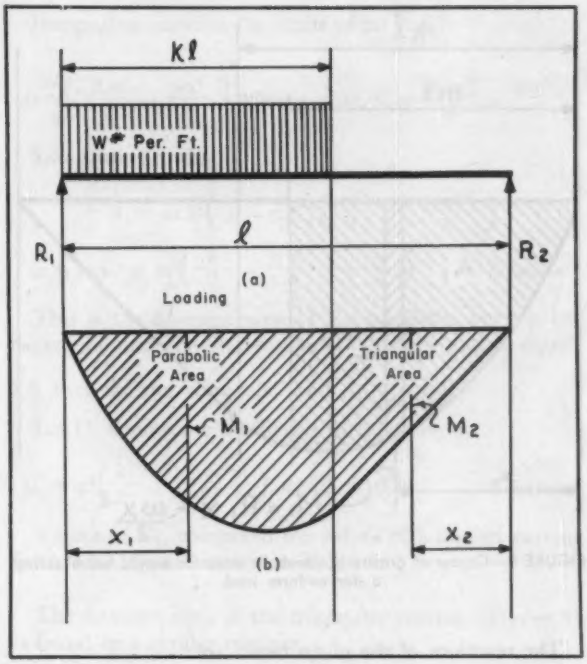


FIGURE 1—Bending moment diagram of simple beam acting under uniform load.

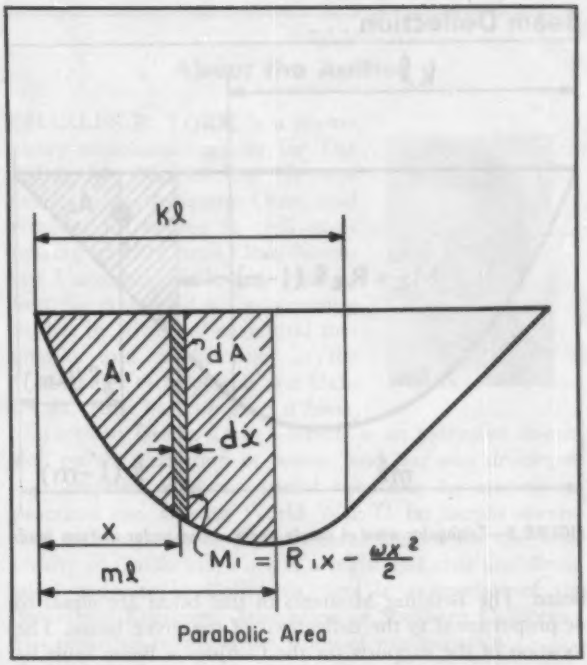


FIGURE 2—Parabolic area of simple beam acting under uniform load.

Easy Methods To Get Beam Deflection

Here's a way to solve your beam deflection problems without using the traditional, tedious, algebraic methods.

Charles H. Fork
The Ralph M. Parsons Company
Los Angeles

THE FUNDAMENTAL principles of Moment Areas provides a useful method for solving deflections, both in angular and linear direction. There is, however, a vast amount of labor involved in making a solution, except for the most elementary problems. The necessary arithmetical and algebraic operations for calculating Moment Areas and their centers of gravity are long and tedious. Many cases require the use of Calculus. Needless to say, this discourages a more general use of these important principles of the structural engineer. It is possible, however, to construct influence lines from these principles to enable one to solve deflections quickly and easily. Also, by their use the expressions for deflections may be shortened, making them less cumbersome for use in algebraic operations: for example, the expression

$$d = \frac{wx}{24EIl}\left[a^2(2l-a)^2 - 2ax^2(2l-a) + lx^3\right]$$

expresses the deflection at any point under load, for a partially uniformly loaded, simple beam. By the use of influence lines the expression may be simply written:

$$d = \frac{Fwl^4}{EI}$$

Equating deflections for making a solution then becomes a simple algebraic process. A convenient method for solving deflections provides the structural engineer with a powerful tool for solving the statically indeterminate elements in continuous structures.

The fundamental Principles of Moment Areas were originally developed and later extended to what is now known as the Conjugate Beam Method. This latter method was chosen as the basis for this work.

One of the principal features of the Conjugate Beam Method is the use of an additional beam, in which the loading is the bending moment diagram of the given

PART 1

Integrating between the limits of m*l* and o =

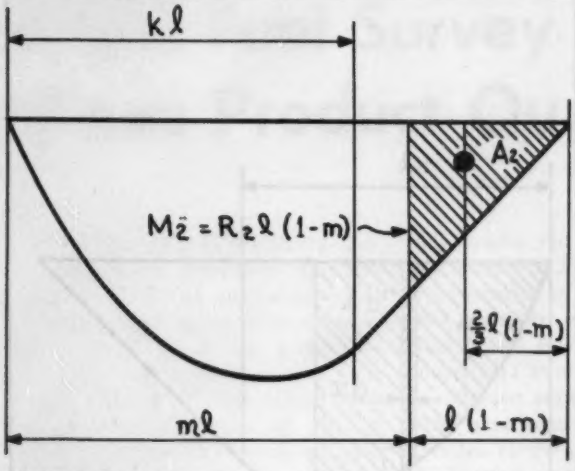


FIGURE 3—Triangular area of simple beam acting under uniform load.

beam. The Bending Moments in this beam are equal to or proportional to the deflections of the given beam. The location of the supports for the Conjugate Beam must be so chosen that where the deflections or the slopes of the given beam have definite values, the Moment and the shear of the Conjugate Beam must be made to assume those definite values. For example, at points where the deflection of the given beam is zero, the Moment in the Conjugate Beam must be made zero, also where the slope of the given beam is zero, the shear in the Conjugate Beam must be made zero.

Area of Moment Diagram—The moment area for any condition of uniform loading varying from no load to a fully loaded span can be easily computed by referring to Table 1. The center of gravity can be obtained from Table 2. These tables were developed in the following manner:

Consider a simple beam loaded uniformly for a distance k*l* from the left support as shown in Figure 1a.

TABLE 1
Values of C_1 for Area of Parabola

	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0	k/m
	.00031	.00073	.0011	.00143	.0017	.0019	.0021	.00223	.0023	.00234	.1
.1	.0020	.00226	.00377	.00507	.0062	.0071	.0078	.00826	.00857	.00867	.2
.2	.0016	.0064	.00697	.0099	.0124	.0144	.0160	.0171	.0178	.018	.3
.3	.0012	.0049	.0110	.0149	.0193	.0229	.0257	.02773	.0289	.0294	.4
.4	.0009	.0036	.0081	.0144	.0261	.0317	.0361	.03916	.0410	.0417	.5
.5	.00063	.0025	.0056	.0100	.0156	.0396	.0460	.0504	.0531	.054	.6
.6	.0004	.0016	.0036	.0064	.0100	.0144	.0544	.0604	.0641	.0653	.7
.7	.00023	.0009	.0020	.0036	.0056	.0081	.0110	.0683	.0731	.0747	.8
.8	.0001	.0004	.0009	.0016	.0025	.0036	.0049	.0064	.0790	.0810	.9
.9	.00003	.0001	.00023	.0004	.00063	.0009	.0012	.0016	.0020	.0833	1.0
1.0	0	0	0	0	0	0	0	0	0	0	
m/k	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0	

VALUES OF C_2 FOR AREA OF TRIANGLE

Use values above zigzag line for parabolic areas.
Use values below zigzag line for triangular areas.

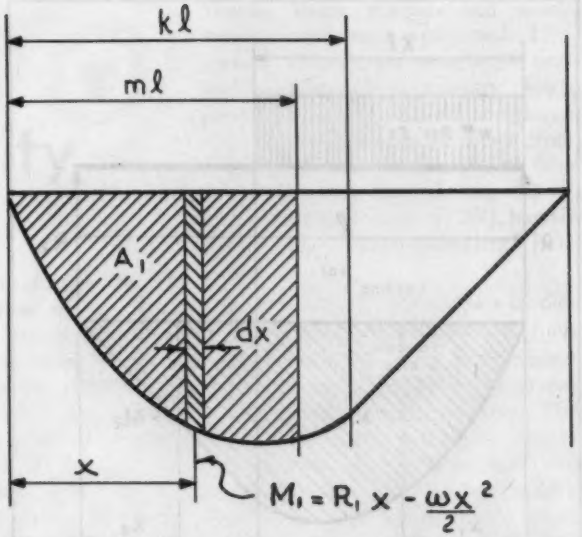


FIGURE 4—Center of gravity of parabolic area for simple beam acting under uniform load.

The reactions of the given beam are:

$$R_1 = wl \times k\left(1 - \frac{k}{2}\right)$$

$$R_2 = wl \times \frac{k^2}{2}$$

The bending moment at any point between k*l* and the left support equals:

$$M_1 = R_1x_1 - \frac{wx_1^2}{2}$$

The bending moment at any point between k*l* and the right support—$M_2 = R_2x_2$. If bending moments are plotted, a diagram is obtained as shown in Figure 1b.

To determine the parabolic moment area between m*l* and the left support in Figure 2, first find the differential area.

$$dA_1 = R_1xdx - \frac{wx^2dx}{2}$$

The total area =

$$\int dA_1 = \int_0^{ml} R_1xdx - \int_0^{ml} \frac{wx^2dx}{2}$$

TABLE 2
Values of n for Center of Gravity of Parabola

k/m	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0	k/m
.1	.0623	.0648	.0654	.0657	.0658	.0659	.0660	.0661	.0661	.0661	.1
.2		.1235	.1275	.1290	.1297	.1302	.1305	.1306	.1307	.1308	.2
.3			.1840	.1890	.1910	.1920	.1930	.1934	.1937	.1938	.3
.4				.2430	.2480	.2510	.2530	.2540	.2540	.2540	.4
.5					.3000	.3060	.3090	.3110	.3122	.3125	.5
.6						.3540	.3610	.3640	.3660	.3670	.6
.7							.4060	.4120	.4150	.4160	.7
.8								.4500	.4560	.4570	.8
.9									.4850	.4875	.9
1.0										.5000	1.0

Beam Deflection . . .

Integrating between the limits of ml and o =

$$A_1 = \int_0^{ml} \left[\frac{R_1 x^3}{2} - \frac{wx^3}{6} \right]. \text{ When } x = ml,\ A_1 = \frac{R_1 m^3 l^3}{2} - \frac{wm^3 l^3}{6}$$

Substituting for R_1—

$$A_1 = wl \times \left(1 - \frac{k}{2}\right)\left(\frac{m^2 l^2}{2} - \frac{wm^3 l^3}{6}\right)$$

$$\text{or } A_1 = wl^4 \times m^3\left(\frac{k}{2} - \frac{k^2}{4} - \frac{m}{6}\right) \quad \text{... Equation 1}$$

This is the moment area of the parabolic portion between ml and the left support. When m and k equals 1.0, then ml and kl equals l and $A_1 = \frac{1wl^4}{12}$

Let C_1 denote the coefficient in Equation 1.

$$C_1 = m^3\left(\frac{k}{2} - \frac{k^2}{4} - \frac{m}{6}\right), \text{ then } A_1 = C_1 wl^4 \quad \text{... Equation 2}$$

Values of C_1, computed for values of k and m varying from 0 to 1.0, are shown in Table 1.

The moment area of the triangular portion (Figure 3) is found in a similar manner.

$$R_2 = wl \times \frac{k^2}{2},\ M_2 = R_2 l\,(1 - m)$$

Substituting for R_2, $M_2 = \frac{wl^3 k^2\,(1-m)}{2}$ which is the bending moment at any point to the right of the load.

The moment area of the triangle between ml and the right support is:

$$A_2 = \frac{wl^3 k^2\,(1-m)}{2} \cdot \frac{l\,(1-m)}{2} \text{ or } A_2 = \frac{wl^3 k^2\,(1-m)^2}{4}$$

... Equation 3

When m and k = 1.0, then ml and kl = l and $A_2 = 0$. Let C_2 denote the coefficient in Equation 3, then $A_2 = C_2 wl^3$.

... Equation 4

Values of C_2 are also computed and found in Table 1.

Center of gravity—To determine the center of gravity of the parabolic moment area in Figure 4, first determine the statical moment of the differential moment area about the left support.

$$dM = R_1 x^3 dx - \frac{wx^3}{2} dx$$

Integrating between the limits of ml and o:

$$\int dM = \int_0^{ml} R_1 x^3 dx - \int_0^{ml} \frac{wx^3}{2} dx$$

$$M = \int_0^{ml} \left[\frac{R_1 x^3}{3} - \frac{wx^4}{8} \right]$$

When x = ml and substituting for R_1

$$M = wl^4 m^3\left(\frac{k}{3} - \frac{k^2}{6} - \frac{m}{8}\right) = \text{statical moment}$$

About the Author

CHARLES R. FORK is a supervisory structural engineer for The Ralph M. Parsons Co. He was raised in northwestern Ohio, and received his degree in civil engineering in 1912 from Ohio Northern University. Following graduation, he continued his engineering studies in advanced structural mechanics and mathematics at the Universities of Michigan and California. Fork has compiled a book, "Structural Design Data," which is an extensive discussion on the deflection of beams, and has also developed and graphed numerous useful equations for convenient practical use. During World War II he taught several war training courses in Structural Design for the University of California. Fork is a registered civil and structural engineer in California, and is a member of the Structural Engineers Association of Southern California. His principal hobby is the study of mathematics.

The center of gravity = $\frac{\text{Statical moment}}{\text{area}}$

$$= \frac{wl^4 m^3\left(\frac{k}{3} - \frac{k^2}{6} - \frac{m}{8}\right)}{wl^3 m^3\left(\frac{k}{2} - \frac{k^2}{4} - \frac{m}{6}\right)} = l\ \frac{m\left(\frac{k}{3} - \frac{k^2}{6} - \frac{m}{8}\right)}{\left(\frac{k}{2} - \frac{k^2}{4} - \frac{m}{6}\right)}$$

... Equation 5

Let n denote the coefficient in Equation 5 then the center of gravity = nl. Values of n were computed for values of k and m varying from 0 to 1.0 and are found in Table 2.

Example: Determine the total moment area for the bending moment diagram in Figure 6 when k = 0.8 and m = 0.8.

From Equation 2—$A_1 = C_1 wl^3$.

From Table 1, at k = .8 and m = .8, C_1 = .0683.

Then A_1 = .0683 wl^3.

Triangular area: $A_2 = C_2 wl^3$.

From Table 1, at k = .8 and m = .8, C_2 = .0064.

Then A_2 = .0064 wl^3.

Total Area = .0683 wl^3 + .0064 wl^3 = .0767 wl^3.

Center of gravity of parabolic area = .45l from Table 2.

Example: Determine a part of the parabolic and triangular moment-areas as shown shaded in Figure 7.

ml—Measures the portion of the moment-areas under consideration.

Parabola:

When k = .8 and m = .4, from Table 1—C_1 = .02773.

Then A_1 = 0.2773 wl^3.

Triangle:

When k = .8 and m = .9 from Table 1—C_2 = .0016. Then $A_2 = .0016\ wl^3$.

Deflection at Any Point—The deflection of a simple beam at any point under uniform load can easily be computed by referring to Table 3. This table was developed in the following manner:

The bending moment at any point between *left* support and k (Figure 8c) is determined as follows: First find the reactions as shown in Figure 8a.

To find the Conjugate Beam reaction $\overset{*}{R}_1$, take the moments about $\overset{*}{R}_2$

$$\overset{*}{R}_1 l - C_1 wl^3 (1-n) - C_2 wl^3 \cdot \frac{2}{3} l (1-k) = 0$$

$$\overset{*}{R}_1 = wl^3 \left[C_1 (1-n) + C_2 \cdot \frac{2}{3} (1-k) \right] \quad \text{... Equation 6}$$

To find the reaction $\overset{*}{R}_2$, take the moments about $\overset{*}{R}_1$

$$\overset{*}{R}_2 l - C_1 wl^3 \cdot nl - C_2 wl^3 \cdot \frac{1}{3} l (1+2k) = 0$$

$$\overset{*}{R}_2 = wl^3 \left[C_1 n + C_2 \cdot \frac{1}{3} (1+2k) \right] \quad \text{... Equation 7}$$

Let the coefficients of wl^3 in equations 6 and 7 be denoted by D_1 and D_2 respectively, and multiply wl^3 by the square of 12 reducing to inch units, that is,

$$D_1 = 144 \left[C_1 (1-n) + C_2 \cdot \frac{2}{3} (1-k) \right]$$

$$D_2 = 144 \left[C_1 n + C_2 \cdot \frac{1}{3} (1+2k) \right]$$

Then $\overset{*}{R}_1 = D_1 wl^3$ and $\overset{*}{R}_2 = D_2 wl^3$

Dividing by the flexural modulus EI gives the angular rotation at each end of the beam.

$$\theta_1 = \frac{D_1 wl^3}{EI} \text{ and } \theta_2 = \frac{D_2 wl^3}{EI}$$

The bending moments as shown in Figure 8c may now be expressed as follows:

$$\overset{*}{M}_1 = D_1 wl^3 \cdot ml - C_1 wl^3 \cdot l (m-n)$$

$$\text{or, } \overset{*}{M}_1 = wl^4 [D_1 m - C_1 (m-n)] \quad \text{... Equation 8}$$

The bending moment at any point between the *right* support and kl (Figure 8d) may be expressed as follows:

$$\overset{*}{M}_2 = D_2 wl^3 \cdot l (1-m) - C_2 wl^3 \cdot \frac{1}{3} l (1-m)$$

$$\text{or, } \overset{*}{M}_2 = wl^4 \left[D_2 (1-m) - C_2 \cdot \frac{1}{3} (1-m) \right] \text{. Equation 9}$$

Let the coefficients of wl^4 in Equations 8 and 9 be denoted by F_1 and F_2, respectively; also multiply wl^4 by the cube of 12, thus reducing to inch units, that is,

$$F_1 = 1728 \left[\frac{D_1}{144} \cdot m - C_1 (m-n) \right]$$

$$F_2 = 1728 \left[\frac{D_2}{144} (1-m) - C_2 \cdot \frac{1}{3} (1-m) \right]$$

Then $\overset{*}{M}_1 = F_1 wl^4$ and $\overset{*}{M}_2 = F_2 wl^4$ and from fundamental principles: $d = \frac{\overset{*}{M}}{EI}$

$$\text{Therefore: } d_1 = \frac{F_1 wl^4}{EI} \text{ and } d_2 = \frac{F_2 wl^4}{EI} \quad \text{... Equation 10}$$

Values of F_1 and F_2 have been calculated for values of k and m, varying from 0 to 1.0 and are found in Table 3. F_1 and F_2 are denoted in the table by F. The

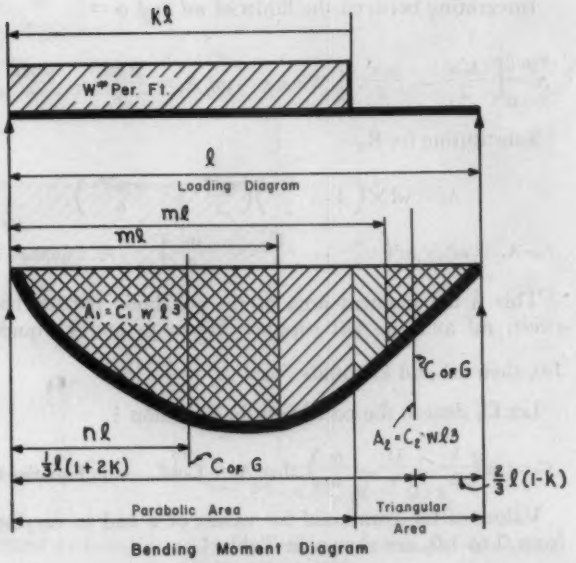


FIGURE 5—Bending moment and loading diagram of simple beam acting under uniform load.

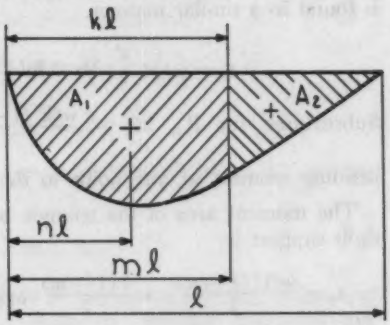


FIGURE 6—Example.

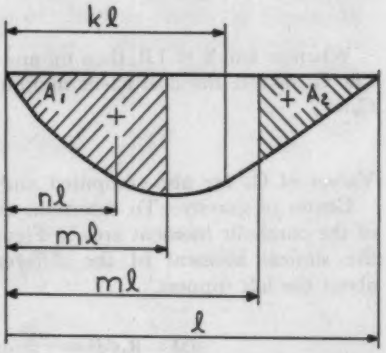


FIGURE 7—Example.

value of "kl" measures the length of the load, and "ml" locates the position of the desired deflection. Values of D_1 and D_2 are shown in Table 3. Values of C_1 and C_2, coefficients for the parabolic and triangular areas respectively, have been taken from Table 1. Values of "n" coefficient for the center of gravity of the parabolic area

TABLE 3
Values of D_1 and D_2 Coefficients for Angular Rotation at Supports

k	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
D_1	.215	.776	1.55	2.45	3.38	4.25	4.98	5.53	5.88	6.0
D_2	.108	.469	1.03	1.76	2.63	3.53	4.45	5.23	5.78	6.0

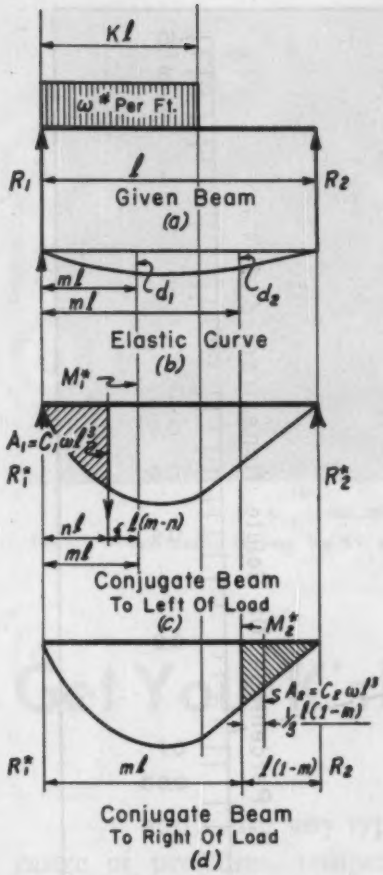


FIGURE 8—Given and Conjugate beam diagrams of a simple beam acting under uniform load.

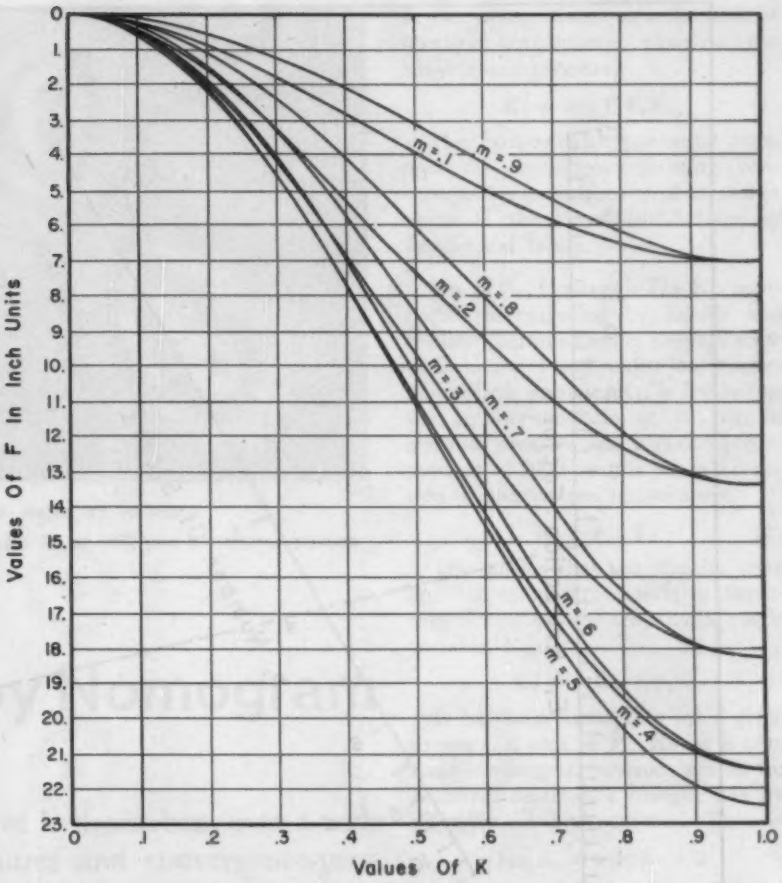


FIGURE 9—Deflection coefficients for simple beam under uniform load.

have also been taken from Table 2. Values of F in Table 4 are also plotted in Figure 9. These curves represent influence lines for the deflection as the load moves over the span.

Example: Determine the deflection of a beam 7'-2" from the left support, when the beam is loaded as shown in Figure 7. E = 30,000,000 and I = 441.8.

TABLE 4
Table Values of F, Deflection Coefficients for Uniform Load

m \ k	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
.0	0	0	0	0	0	0	0	0	0	0
.1	.24	.92	1.80	2.85	3.95	4.97	5.84	6.52	6.92	6.99
.2	.41	1.55	3.26	5.26	7.34	9.31	10.98	12.32	13.09	13.36
.3	.51	1.97	4.21	6.98	9.82	12.57	14.94	16.81	17.92	18.30
.4	.55	2.12	4.60	7.72	11.12	14.40	17.30	19.61	20.95	21.43
.5	.53	2.09	4.55	7.70	11.22	14.78	17.93	20.47	21.98	22.50
.6	.47	1.88	4.16	7.00	10.30	13.67	16.62	19.35	20.88	21.43
.7	.39	1.53	3.35	5.73	8.48	11.33	14.15	16.50	17.84	18.30
.8	.27	1.08	2.36	4.05	6.01	8.07	10.10	11.90	13.02	13.36
.9	.12	.55	1.22	2.09	3.11	4.19	5.26	6.17	6.89	6.00
1.0	0	0	0	0	0	0	0	0	0	0

Note: Coefficients "F" are in inch units. Divide by 1728 for foot units.

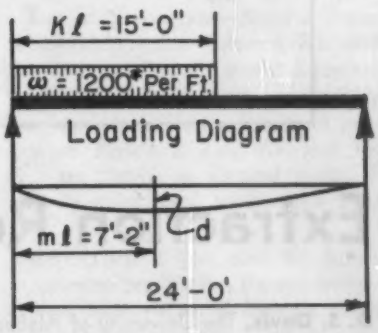


FIGURE 10
Example

$$k = \frac{15'\text{-}0''}{24'\text{-}0''} = .625 \qquad m = \frac{7'\text{-}2''}{24'\text{-}0''} = .3$$

Then from the chart, F = 13.2 and $d = \frac{Fwl^4}{EI}$

$$d = \frac{13.2 \times 1200\# \times 24^4}{30{,}000{,}000 \times 441.8} = .396''$$

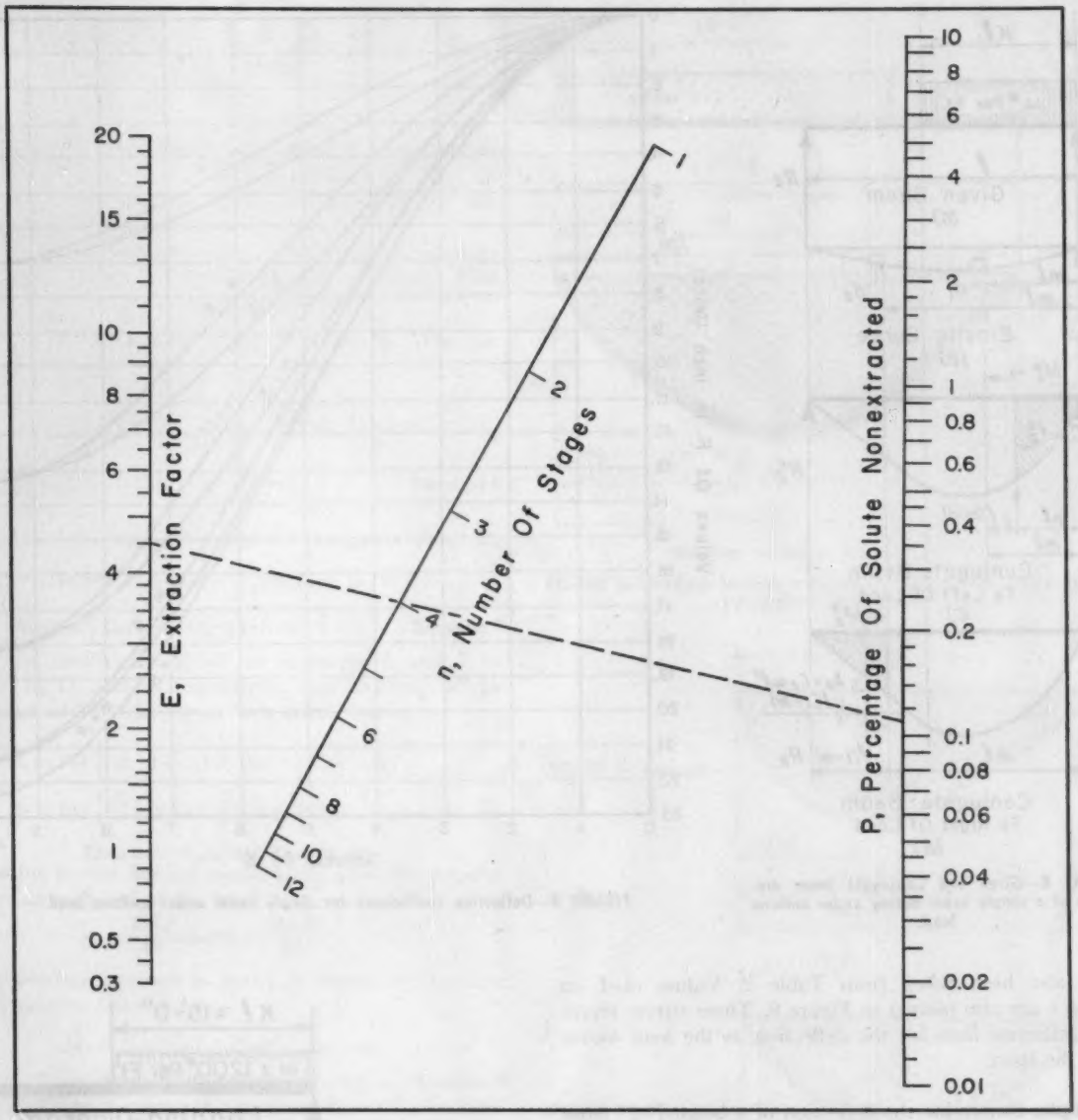
ACKNOWLEDGMENT

From a privately circulated book by Charles H. Fork entitled "Structural Design Data on Deflection of Beams" upon which the author holds the copyright.

Part 2 will appear in an early issue of Petroleum Refiner

##

K can be correlated as a function of



Extraction Results in a Hurry

D. S. Davis, The University of Alabama
Tuscaloosa, Ala.

FOR CROSSCURRENT liquid-liquid extraction, Alders[1] gives the equation

$$P = \frac{100}{(E+1)^n}$$

where P = percentage of solute nonextracted,
E = extraction factor, ratio of amount of one component in the extract phase to amount of the same component in the raffinate phase,
and n = the number of extraction stages.

Example: The index line shows that 0.11 percent of nonextracted solute can be attained with four crosscurrent stages when the extraction factor is 4.5.

How many crosscurrent stages are needed to reduce the percentage of nonextracted solute to 0.5 when the extraction factor is 2.0? Align 2.0 on the E scale with 0.5 on the P scale and note the intersection with the n scale at about 4.8. Five crosscurrent stages would then be required.

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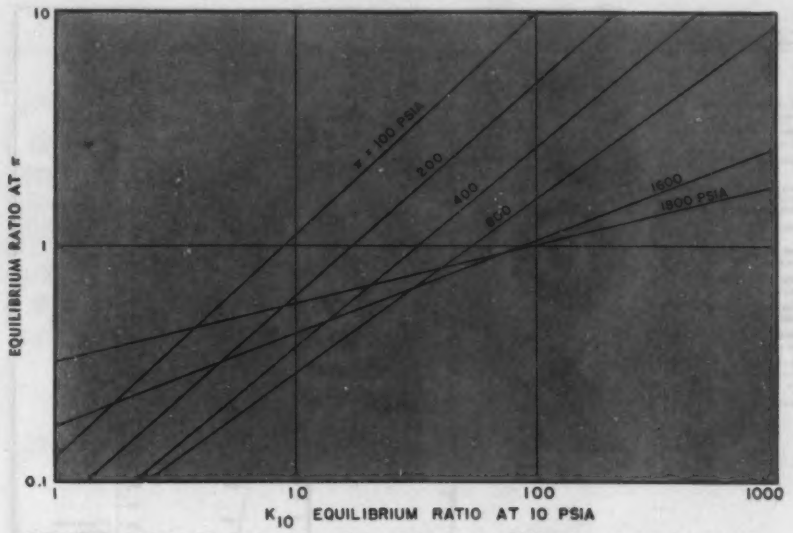

FIGURE 1—Relationship between log K_π and log K_{10} at 2000 psia convergence pressure.

Get Your K's by Nomogram

. . . for any type of hydrocarbon, over a wide range of pressures, temperatures and convergence-pressures. You'll have the same accuracy as any of the more difficult current methods.

H. S. Myers and **J. M. Lenoir**
C F Braun and Company
Alhambra, California

THE EQUILIBRIUM-RATIO, K, of a component is defined as y/x, the molal concentration of the component in the vapor divided by its concentration in the liquid, at equilibrium. Four factors influence this ratio—the identity of the component, the temperature, the pressure, and the amount and identity of other components in the mixture.

It is the last of these factors, system composition, that often causes difficulty when we try to predict equilibrium-ratios. Sometimes, at relatively low pressures, composition is not important, and we can use an idealized approach such as Raoult's law, either with vapor pressures or fugacities. But at high pressures these idealized equations can predict K values that are greatly in error because the effect of composition is not considered.

Convergence Pressure—Several investigators,[7, 8, 12, 13, 20, 27] have shown that convergence-pressure can be used in place of the composition variable to predict equilibrium-ratios. That is, K can be correlated as a function of identity, temperature, pressure and convergence-pressure.

$$K_\pi = \phi(i, T, P, P_\pi) \qquad (1)$$

The nomograph presented here, uses the convergence-pressure concept, and is an outgrowth of an earlier paper in the Petroleum Refiner by Lenoir and White.[12]

Use of K_{10} Concept—The K_{10} technique, introduced by Lenoir and White,[12] permits further simplification of Equation 1 and makes the present nomograph possible. K_{10} is defined as the equilibrium-ratio at 10 pounds absolute pressure and a convergence-pressure of 5000 pounds. K_{10} is a function of identity and temperature.

$$K_{10} = \Theta(i, T) \qquad (2)$$

This means that the identity term and the temperature term in Equation 1 can be replaced by a single variable, K_{10}.

$$K_\pi = \psi(K_{10}, P, P_\pi) \qquad (3)$$

It has been found that for a given pressure, a plot of log K_π at a constant convergence-pressure against log K_{10}, will result in a straight line for all types of hydrocarbons. That is,

$$\text{Log } K_\pi = a \log K_{10} + b \qquad (4)$$

where a and b are functions of P and P_π only. Figure 1 illustrates the relationship for a convergence-pressure of 2000 pounds.

Use of Nomogram—Since a linear relationship exists between K_π and K_{10}, it is possible to present Equation 3 in the form of a nomograph. This has been done on the left-hand portion of Figure 2. Log K_π and log K_{10} are shown as vertical scales. P and P_π have been constructed as a grid.

Equation 2 can also be nomographed to predict K_{10} for any hydrocarbon from either its identity or its normal boiling-point. This is illustrated by the right-hand section of Figure 2. The nomograph of Winn[27] uses a similar, empirical scale for normal boiling-point.

Figure 3 is an expansion of the high-pressure region of Figure 2 to permit easier reading. For simplicity, the right-hand portion of Figure 2 has not been repeated on Figure 3.

Experimental data show that at convergence-pressures of around 2000 pounds, Equation 4 is valid to very high values of K_{10}. At higher con-

Enlarged copies of the nomograms are available from the authors upon request

Get Your K's by Nomogram . . .

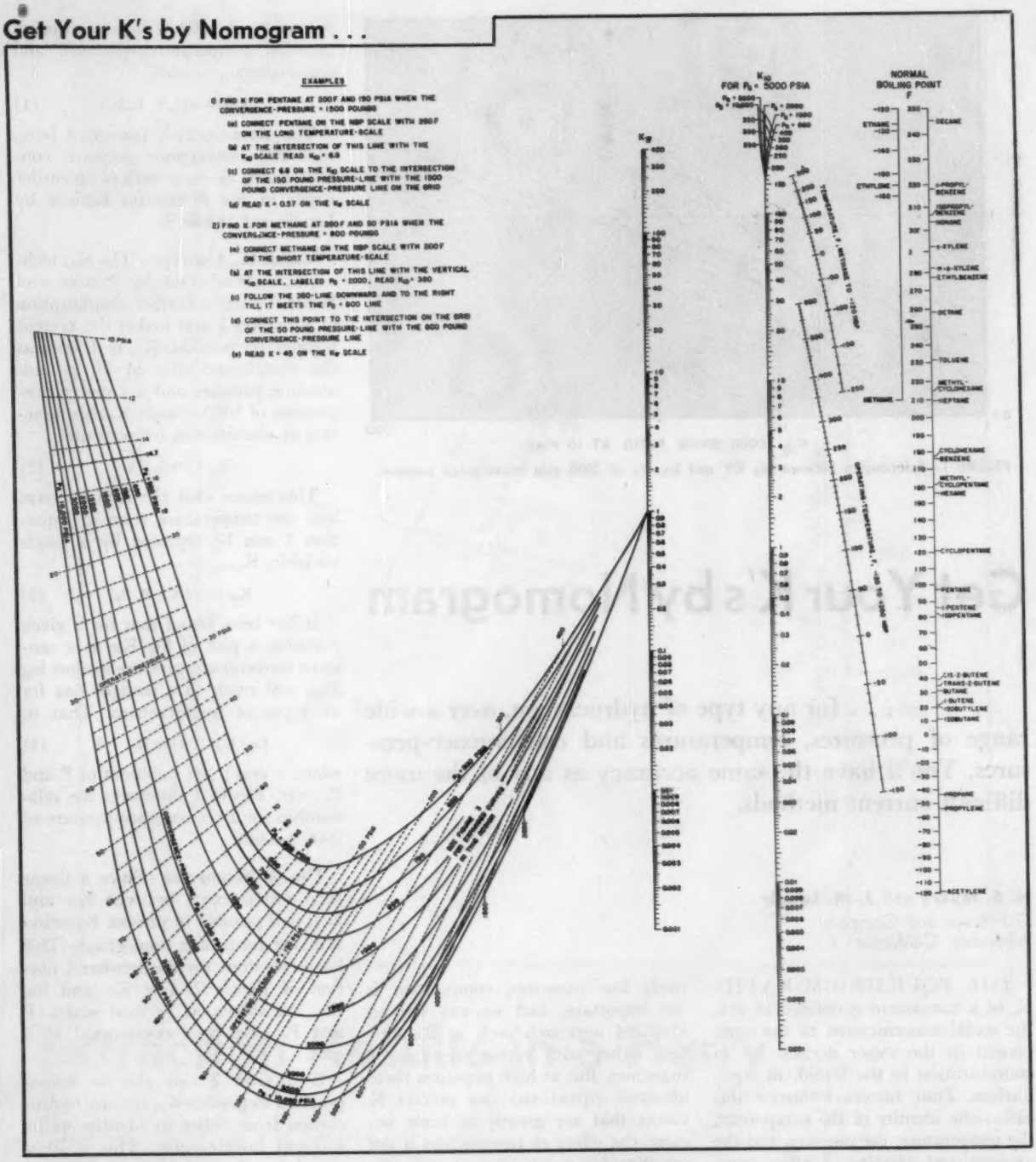
EXAMPLES
1) FIND K FOR PENTANE AT 200F AND 150 PSIA WHEN THE CONVERGENCE-PRESSURE = 1500 POUNDS
(a) CONNECT PENTANE ON THE NBP SCALE WITH 200F ON THE LONG TEMPERATURE-SCALE
(b) AT THE INTERSECTION OF THIS LINE WITH THE K_{10} SCALE READ K_{10} = 6.8
(c) CONNECT 6.8 ON THE K_{10} SCALE TO THE INTERSECTION OF THE 150 POUND PRESSURE-LINE WITH THE 1500 POUND CONVERGENCE-PRESSURE LINE ON THE GRID
(d) READ K = 0.57 ON THE K_π SCALE
2) FIND K FOR METHANE AT 200F AND 50 PSIA WHEN THE CONVERGENCE-PRESSURE = 800 POUNDS
(a) CONNECT METHANE ON THE NBP SCALE WITH 200F ON THE SHORT TEMPERATURE-SCALE
(b) AT THE INTERSECTION OF THIS LINE WITH THE VERTICAL K_{10} SCALE, LABELED P_5 = 2000, READ K_{10} = 380
(c) FOLLOW THE 380-LINE DOWNWARD AND TO THE RIGHT TILL IT MEETS THE P_5 = 800 LINE
(d) CONNECT THIS POINT TO THE INTERSECTION ON THE GRID OF THE 50 POUND PRESSURE-LINE WITH THE 800 POUND CONVERGENCE-PRESSURE LINE
(e) READ K = 45 ON THE K_π SCALE
K_π
K_{10} FOR P_5 = 5000 PSIA
NORMAL BOILING POINT
F
DECANE
n-PROPYL-BENZENE
ISOPROPYL-BENZENE
NONANE
o-XYLENE
m-p-XYLENE
ETHYLBENZENE
OCTANE
TOLUENE
METHYL-CYCLOHEXANE
HEPTANE
CYCLOHEXANE
BENZENE
METHYL-CYCLOPENTANE
HEXANE
CYCLOPENTANE
PENTANE
i-PENTENE
ISOPENTANE
cis-2-BUTENE
TRANS-2-BUTENE
BUTANE
i-BUTENE
ISOBUTYLENE
ISOBUTANE
PROPANE
PROPYLENE
ACETYLENE
ETHANE
ETHYLENE
METHANE

FIGURE 2—You may obtain equilibrium constants by knowing the identity of a hydrocarbon or its normal boiling point.

vergence-pressures, the plot of log $K\pi$ versus log K_{10} turns upward at values of K_{10} above about 160. At convergence-pressures below 2000 pounds, the curves break downward at K_{10} values above about 160.

Normally, a K_{10} value of 160 or higher can apply only to methane, although ethane or ethylene could possibly fall in this region at very high temperatures. The crows-foot at the upper end of the K_{10} scale adjusts for this abnormal behavior of methane and other light hydrocarbons at high values of K_{10}.

The nomograph is especially adapted for use with multicomponent mixtures. A pencil point, or pin, is placed at the proper place in the grid of Figure 2 or 3. By swinging a straight edge around the point or pin, rapid evaluation of $K\pi$ values can be made.

Use of the nomograph presumes a known value of convergence-pressure. Several methods are available for estimating convergence-pressure.[7, 12, 20]

Accuracy—Table 1 shows some equilibrium-ratios predicted from the nomograph compared with experimental data. The arithmetic average deviation is 7.3 percent. Most of the modern methods,[2, 6, 12, 13, 15, 20, 27] to predict equilibrium-ratios claim an

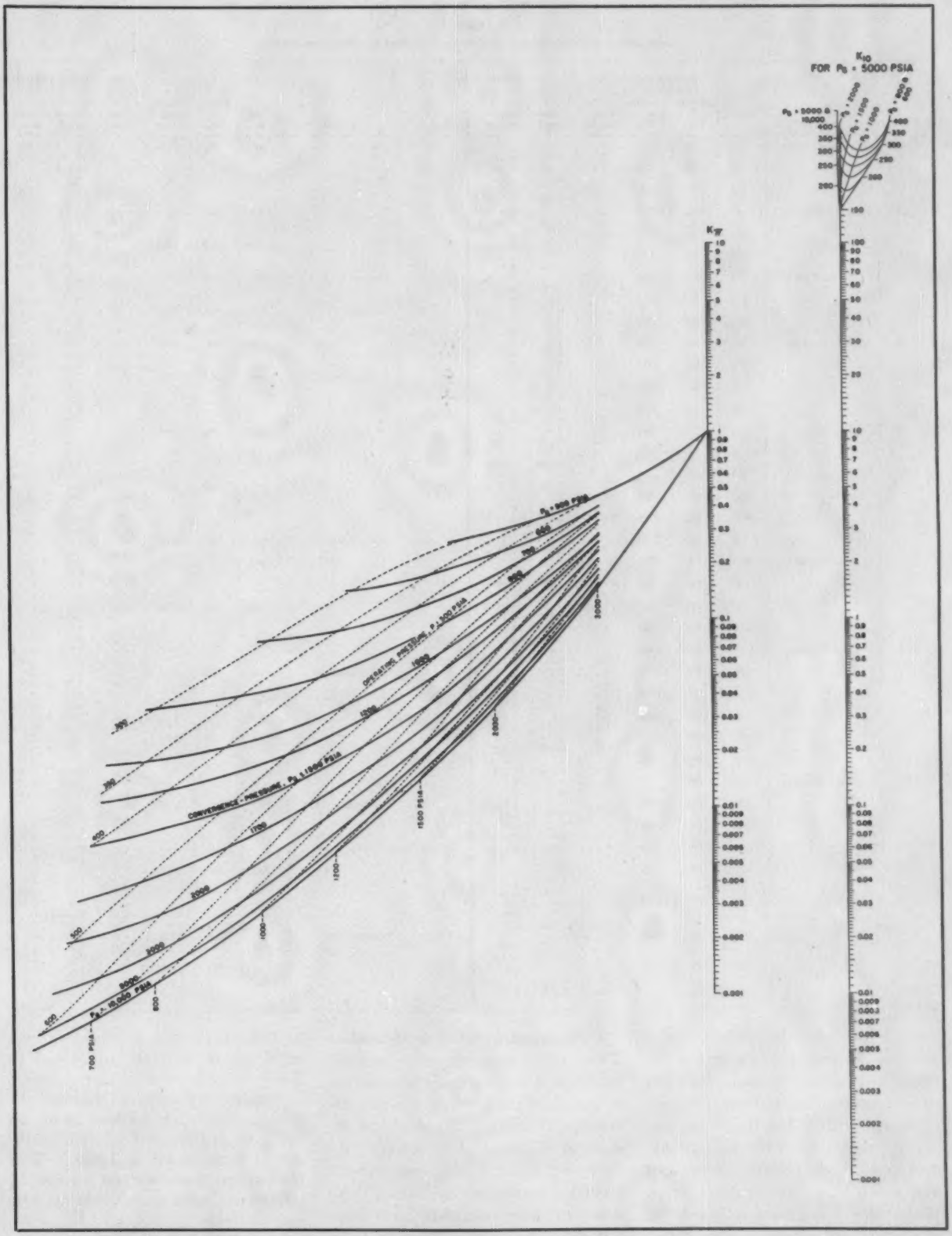

FIGURE 3—Here's an expansion of the high pressure range of Figure 2 to make it easier to work in this region.

TABLE 1
Comparison of Predicted and Experimental Equilibrium-Ratios

Reference	System	Temp. F	PRESSURE: System P Psia	PRESSURE: Convergence P Psia	Component	EQUILIBRIUM—RATIOS: Nomograph	EQUILIBRIUM—RATIOS: Experimental
19	Methane-Ethane	32	880	1160	C_1	2.0	1.74
					C_2	0.77	0.77
		−109	558	780	C_1	1.48	1.28
					C_2	0.22	0.23
		−155	147	1700	C_1	2.3	2.7
					C_2	0.060	0.09
23	Methane-Propane	68	735	1450	C_1	3.1	3.0
					C_3	0.38	0.38
		104	588	1350	C_1	3.8	3.6
					C_3	0.55	0.54
		158	588	1120	C_1	3.5	3.4
					C_3	0.85	0.81
21	Methane-Butane	220	400	1490	C_1	6.7	6.8
					C_4	0.71	0.71
		190	300	1680	C_1	9.0	9.3
					C_4	0.66	0.66
		250	1000	1200	C_1	1.98	1.98
					C_4	0.72	0.73
24	Methane-Pentane	100	400	2455	C_1	7.0	7.3
					C_5	0.078	0.078
		160	600	2338	C_1	5.3	5.3
					C_5	0.147	0.146
		220	600	2081	C_1	5.4	5.3
					C_5	0.27	0.28
		280	600	1610	C_1	4.7	4.7
					C_5	0.46	0.50
10	Ethane-Heptane	133	200	930	C_2	3.6	3.7
					C_7	0.036	0.030
		71	400	1200	C_2	1.36	1.29
					C_7	0.0086	0.0089
11	Ethylene-Heptane	310	400	1460	$C_2^=$	4.1	4.6
					C_7	0.245	0.25
		310	800	1460	$C_2^=$	2.2	2.4
					C_7	0.24	0.23
		370	600	1270	$C_2^=$	3.1	3.15
					C_7	0.36	0.38
		340	800	1380	$C_2^=$	2.3	2.4
					C_7	0.30	0.30
14	Propane-Butane	190	200	660	C_3	2.15	2.15
					C_4	0.96	0.90
		190	400	660	C_3	1.29	1.24
					C_4	0.68	0.54
		190	500	660	C_3	1.13	1.04
					C_4	0.68	0.47
		250	500	640	C_3	1.35	1.39
					C_4	0.89	0.80
1	Methane-Propane	32	200	1460	C_1	9.6	9.1
					C_3	0.46	0.42
		−25	200	1410	C_1	7.4	7.75
					C_3	0.17	0.15
		−52	200	1350	C_1	6.1	6.7
					C_3	0.094	0.098
		−52	400	1350	C_1	3.2	3.3
					C_3	0.071	0.075
		−76	600	1240	C_1	1.89	1.76
					C_3	0.050	0.062
		−109	200	700	C_1	3.4	3.5
					C_3	0.026	0.020
22	Propane-Pentane	220	200	650	C_3	2.55	2.6
					C_5	0.60	0.59
		220	400	650	C_3	1.48	1.38
					C_5	0.48	0.44
		310	400	640	C_3	1.97	1.94
					C_5	0.81	0.79
		340	400	600	C_3	2.05	2.1
					C_5	0.96	0.90
4.5	Ternary	100	500	1665	C_1	5.1	5.0
					C_3	1.41	1.33
					C_5	0.080	0.102
		100	500	2150	C_1	5.5	5.5
					C_3	0.55	0.504
					C_5	0.072	0.075
		100	500	2300	C_1	5.5	5.7
					C_3	0.54	0.50
					C_5	0.072	0.072
		160	1000	1990	C_1	2.9	2.9
					C_3	0.62	0.57
					C_5	0.160	0.18
4.5	Ternary	100	500	1700	C_1	4.9	4.9
					C_3	0.56	0.52
					C_5	0.078	0.125
3	Ternary	100	500	1670	C_1	4.9	4.7
					$C_3^=$	1.37	1.80
					IC_4	0.27	0.27
		100	500	1500	C_1	4.7	4.8
					$C_3^=$	1.32	1.72
					IC_4	0.27	0.29
		100	1000	1600	C_1	2.4	2.3
					$C_3^=$	1.20	1.10
					$IC_4^=$	0.28	0.29
3	Ternary	160	500	1530	C_1	5.0	5.0
					$C_3^=$	2.4	2.1
					IC_4	0.49	0.50
16	Ternary	280	600	3800	C_1	6.2	6.1
					C_4	0.76	0.90
					C_{10}	0.026	0.029
		280	1000	3800	C_1	3.95	3.9
					C_4	0.62	0.69
					C_{10}	0.031	0.031
8	Multicomponent	100	517	2250	C_1	5.4	5.7
					C_2	1.40	1.51
					C_3	0.53	0.41
					C_4	0.19	0.175
					C_5	0.071	0.060
		100	946	2200	C_1	3.15	3.0
					C_2	0.96	0.87
					C_3	0.42	0.37
					C_4	0.179	0.122
					C_5	0.076	0.089
		100	1046	2200	C_1	2.8	2.6
					C_2	0.92	0.84
					C_3	0.42	0.39
					C_5	0.079	0.11
					C_6	0.035	0.054
18	Multicomponent	200	587	4000	C_1	6.8	7.3
					C_2	2.15	2.15
					C_3	0.99	0.96
					C_4	0.46	0.46
					C_5	0.22	0.21
					C_6	0.107	0.121
		120	486	3800	C_1	6.8	7.3
					C_2	1.67	1.65
					C_3	0.66	0.61
					C_4	0.25	0.25
					C_5	0.096	0.093
					C_6	0.036	0.032
13	Multicomponent	40	765	3600	C_1	3.5	3.9
					C_2	0.70	0.70
					C_3	0.23	0.23
					C_4	0.072	0.081
					C_5	0.024	0.031
					C_6	0.0085	0.0080
		40	499	3600	C_1	5.0	6.3
					C_2	0.91	0.60
					C_3	0.27	0.26
					C_4	0.078	0.063
					C_5	0.024	0.020
					C_6	0.0076	0.007
17	Multicomponent	200	1047	9500	C_1	4.0	4.4
					C_2	1.49	1.41
					C_3	0.75	0.72
					C_4	0.37	0.36
					C_5	0.185	0.171
					C_6	0.095	0.072
		200	1600	9500	C_1	3.0	3.15
					C_2	1.22	1.20
					C_3	0.68	0.59
					C_4	0.36	0.35
					C_5	0.195	0.19
					C_6	0.108	0.085
25	Naphtha-Oil	580	205	790	C_3	3.55	3.6
					C_6	2.6	2.7
					C_7	2.0	2.0
		580	352	790	C_3	2.3	2.4
					C_6	1.70	1.8
					C_7	1.30	1.4

average deviation between 6 and 8 percent. In recent years it has become increasingly evident that the measurement of accurate equilibrium-ratios is difficult. The 6 to 8 percent average deviation of the various prediction methods probably represents the average of experimental error. With the existing data it is realistic to assume a six percent average deviation as an excellent fit to the experimental data.

Comparison with Other Methods— Three other methods are commonly used for predicting equilibrium-ratios by means of the convergence-pressure concept. These are the charts of the Natural Gasoline Association,[18] the tables of Rzasa, Glass, and Opfel,[20] and the nomogram of Winn.[27] All three of these methods have been tested, in the manner shown for the present nomograph, to see how closely they predict the experimental data of Table 1. Results of this comparison of the four methods are shown in Table 2.

Another comparison, showing the deviation of each method from the average prediction of all four methods, is summarized in Table 3. This comparison indicates no significant differences in the accuracy of the various methods.

Molal average boiling-point, instead of convergence-pressure, is also used as a correlating parameter for

TABLE 2
Deviation of Predicted From Measured Values Over-All Deviations

Range, 40 to 500 F, P_z from 1000 to 8500 Psia

	NGAA	RZASA	WINN	Present Nomograph
Average arithmetic percent deviation	8.0	9.1	10.1	7.3
Probable prediction error	6.8	7.7	9.0	6.2
Percent of predictions having deviation less than 10 percent	68	64	56	72
Percent of predictions having deviation less than 20 percent	95	92	90	96
Special Ranges				
P_z Less Than 1000 Psia				
Average arithmetic percent deviation	8.2	....	7.2	7.9
Below 40 F:				
Average arithmetic percent deviation	12.3	....	....	9.9
Above 500 F:				
Average arithmetic percent deviation	....	....	15.5	5.4

equilibrium-ratios. The charts published by M. W. Kellogg Co., titled Liquid-Vapor Equilibrium in Mixtures of Light Hydrocarbons, are based on this molal average boiling-point concept, and have been widely accepted as an accurate, but tedious, procedure for predicting equilibrium-ratios. Table 4 shows the results of a comparison of the present nomograph with the Kellogg charts. The comparison is based on 733 binary mixtures at temperatures from 100 to 400 F, pressures from atmospheric to 1000 psia, and convergence-pressures from 500 to 10,000 psia.

In this comparison, the total average arithmetic deviation of the two methods is 6.7 percent. The Kellogg charts are said to have an average prediction accuracy of 7.1 percent compared with experimental data. This is very close to the 7.3 percent shown by the present nomograph in the Table 1 comparison.

Conclusions—The nomograph presented here is applicable for all types of hydrocarbons, over a wide range of pressures, temperatures, and convergence-pressures. It is comparable in accuracy to any of the current methods for predicting equilibrium-ratios. Its greatest advantage is that it is simple and fast to use. For a given pressure, temperature, and convergence-pressure, equilibrium-ratios can be computed in a matter of seconds, with no interpolation between tables or graphs.

As is the case with other common methods, the nomograph does not correct for liquid-phase nonideality where more than one molecular type is present. For this type of mixture, the equilibrium-ratios predicted by the nomograph must be corrected by the use of suitable activity coefficients.

Enlarged copies of the nomograph are available from the authors upon request.

TABLE 3
Deviation of Individual Prediction From the Average of the Prediction of All Four Methods

	NGAA	RZASA	WINN	Present Nomograph
Arithmetic Percent Deviation	8.71	8.80	6.80	6.87
Probable Deviation	7.36	7.45	5.75	5.80
Percent Trend	2.35	−1.26	0.54	−1.18

TABLE 4
Comparison of Present Nomograph With Kellogg Charts for 733 Binary Mixtures

Overall Average Arithmetic Deviation	6.7 percent
Trend, Kellogg Charts	0.3 percent low
Average Arithmetic Deviation:	
For K Greater Than 1.0	4.8 percent
Trend, Kellogg Charts	1.3 percent high
Average Arithmetic Deviation:	
For K Less Than 1.0	9.1 percent
Trend, Kellogg Charts	2.1 percent low

Deviation Less Than	Percent of Predictions With Deviations Less Than Specified
10 percent	76.9
15 percent	90.0
20 percent	94.3
25 percent	98.2
30 percent	99.6

Meet the Authors

Myers

Lenoir

H. S. MYERS is a research engineer with C F Braun and Co. at Alhambra, Calif. With this company since 1952, he spent the previous eight years with the Petroleum Refining Laboratory at Pennsylvania State University. Dr. Myers received his B.S., M.S., and Ph.D. degrees from Pennsylvania State University.

J. M. LENOIR received his Ph.D. degree from the University of Illinois in 1949. He spent four years as an assistant and associate professor at the University of Arkansas, and two years as a professor at the University of Denver. He has been an engineer for American Oil Co., Texas City, and is presently associated with C F Braun and Co., Alhambra, Calif.

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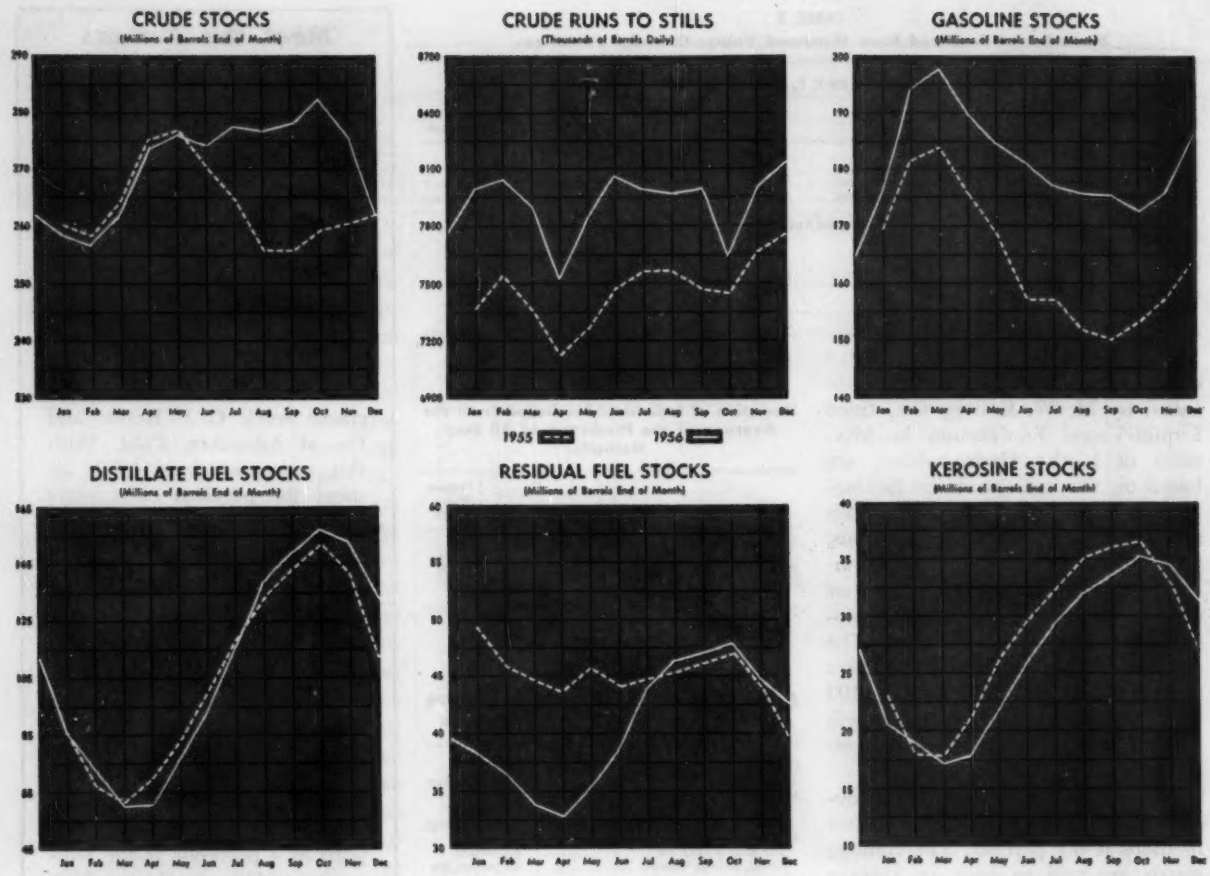


Taking Stock

Cecil W. Smith
Economics Editor

- **Refinery runs at all-time high**
- **Distillate fuel output at peak**
- **Crude stocks being whittled**

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1954:													
November	6,346	6,975	264,566	3,530	150,604	354	34,547	1,622	133,886	1,120	54,891	636	1,104
December	6,394	7,238	258,385	3,605	155,400	381	27,826	1,668	108,144	1,187	52,105	729	1,301
1955:													
January	6,761	7,379	260,156	3,639	169,562	409	23,266	1,740	86,692	1,235	49,457	739	1,348
February	6,835	7,549	258,630	3,655	181,643	374	18,291	1,847	68,513	1,239	46,042	751	1,379
March	6,886	7,374	264,430	3,543	183,972	357	18,187	1,703	62,457	1,185	44,970	742	1,319
April	6,887	7,136	275,232	3,502	175,601	312	21,486	1,534	70,139	1,110	43,838	607	1,123
May	6,677	7,281	276,948	3,605	168,751	296	26,375	1,519	83,559	1,111	45,083	742	1,137
June	6,613	7,484	270,850	3,725	157,439	269	29,830	1,628	100,652	1,080	44,398	764	1,159
July	6,632	7,580	264,601	3,824	157,079	286	32,749	1,575	119,169	1,091	44,894	860	1,161
August	6,665	7,580	256,427	3,858	151,912	290	35,292	1,621	133,675	1,090	45,480	756	1,155
September	6,731	7,483	256,269	3,784	150,194	279	36,361	1,621	143,248	1,061	46,267	829	1,218
October	6,837	7,465	267,346	3,827	153,103	309	36,705	1,612	152,288	1,123	47,040	821	1,206
November	7,014	7,692	260,707	3,867	157,871	341	33,283	1,680	141,808	1,214	44,071	823	1,322
December	7,155	7,762	265,610	3,916	165,433	395	26,770	1,765	111,333	1,286	39,174	884	1,502
1956:													
January	7,199	8,023	261,592	3,927	183,905	385	21,310	1,923	86,141	1,344	38,247	805	1,422
February	7,208	8,047	259,504	3,854	196,092	385	18,712	1,918	71,335	1,286	35,673	878	1,472
March	7,278	7,914	265,683	3,829	199,698	342	17,215	1,808	60,846	1,213	32,984	934	1,425
April	7,146	7,487	277,121	3,646	193,299	299	18,227	1,713	63,571	1,130	32,740	815	1,305
May	7,064	7,896	277,497	3,859	186,673	292	21,883	1,667	75,928	1,149	36,607	938	1,416
June	7,100	8,071	274,491	3,976	177,076	290	26,111	1,755	93,758	1,098	39,073	987	1,426
July	7,090	8,014	277,008	3,975	176,536	296	28,990	1,767	115,787	1,066	43,958	1,084	1,463
August	7,195	7,995	279,944	4,037	172,939	313	31,826	1,839	137,905	1,091	46,617	1,001	1,399
September	7,054	8,024	278,791	3,991	177,974	329	33,588	1,845	150,411	1,062	47,342	1,043	1,452
October	6,966	7,608	286,560	3,773	172,798	356	35,667	1,772	158,871	1,082	48,400	1,004	1,541
November	7,137	8,027	275,910	3,825	175,405	378	34,574	1,822	153,384	1,183	44,376	881	1,323
December	7,376	8,114	263,027	3,959	186,374	383	31,453	1,990	133,742	1,238	42,696	864	1,453
Week Ended:													
1-18-57	7,431	8,120	256,278	3,872	191,373	353	27,542	2,120	114,424	1,275	41,009	597	1,029
1-20-56	7,045	7,952	258,864	3,795	175,785	375	22,711	1,939	94,610	1,331	39,012	808	1,383

Source: Data for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels.

Centrifugal Pump Packings and Seals

Handbook

Part 1 – Packing Boxes and Glands
Part 2 – Packings
Part 3 – Mechanical Seals
Part 4 – Mechanical Seal Maintenance
Part 5 – Packing Maintenance

Here's a way to determine the correct packing for the service application of your pump.

Harold Woodhouse
Dean Hill Pump Company
Indianapolis

ALTHOUGH THERE ARE several types of packing, only the "jam" type is normally applicable to centrifugal pumps. This type includes any packing that is jammed into a packing box and adjusted from time to time by tightening nuts on a gland.

These packings are twisted, woven, bulk, coil, moulded, stick or laminated and of many materials including hemp, flax, wool, ramie, cotton, rubber, leather, fibre, asbestos, soft metals like lead, tin, aluminum and babbitt. In cross-sections the packing may be round, square, wedge or conical.

They may be impregnated with graphite, oils, greases or secret formulas to provide a lubricating film between the surface of the shaft or sleeve and the packing to minimize the friction between the rotating element and the packing. This lubricating quality of the packing is insufficient to permit continued running of the pump without additional lubrication which, most frequently, is oil or water tapped from the pump or supplied from an external source but may be another liquid or grease.

Since a great many centrifugal pump packings have been developed for different applications, it is impossible to list in detail the construction and uses of each variation. The following is to be considered only as a general outline:

Fiber Type Packings—Twisted fiber (Figure 1) is a simple packing suitable only for small pumps without any appreciable pressure on the packing boxes. It is usually graphited and strands may be quickly undone to fit a smaller size box. It is weak and may be easily torn apart.

Part 1 of this series was devoted to construction features and applications of various types of packing boxes and glands. Its purpose was to present the fundamentals of centrifugal pump packings by showing how packing boxes work and the conditions which require different types to be used. The present article indicates the various types of packing that are used in centrifugal pumps, and provides a guide for the selection of the correct packings for the fluid being pumped.

Braided packing has several variations. Its simplest form is the ordinary round or braid-over-braid type (Figure 2). It is built up to the desired diameter by braiding separate covers around a center core. There is no structural bond between the layers so that it is weak. Somewhat of an improvement is the ordinary square braid, Figure 3, where each strand passes over and under other strands running in the opposite general direction. No strands pass entirely through the packing and no single strand is linked with all the other strands so that it is also a weakly constructed packing.

An interlocking or lattice type of braid is made so that every strand passes diagonally through the body of the packing at an angle of 45 degrees, Figure 4. This makes a completely unified structure which is braided *internally* as well as externally. Every strand contributes to the strength of the entire mass. Wear does not loosen the strands. It has unusual flexibility so that large packing sizes may be bent into small diameter rings without distortion of the square cross-section.

Braided packing may be jute, cot-

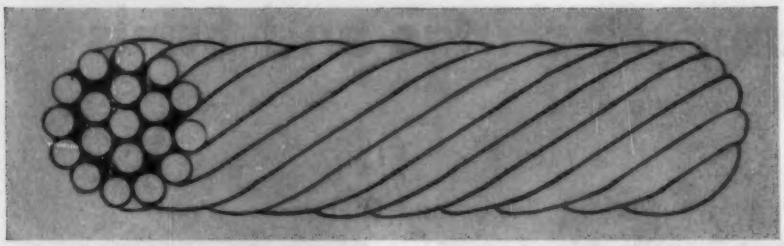


FIGURE 1—Twisted fiber packing for small pumps.

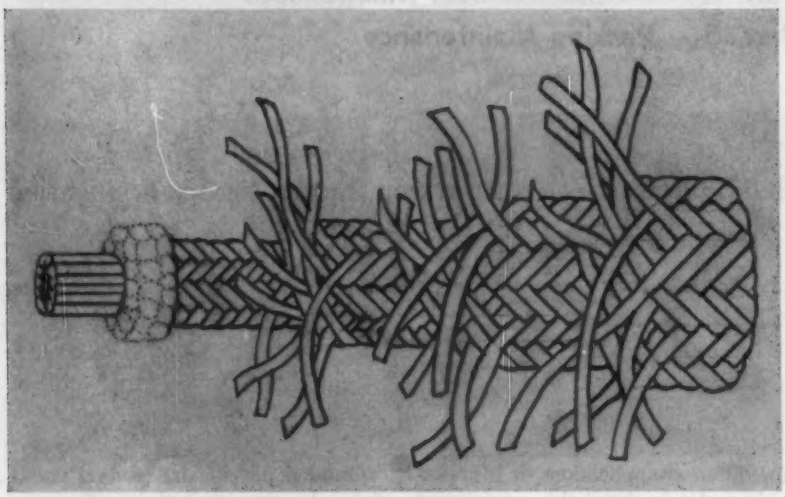


FIGURE 2—Round, braided packing has separate covers around a center core.

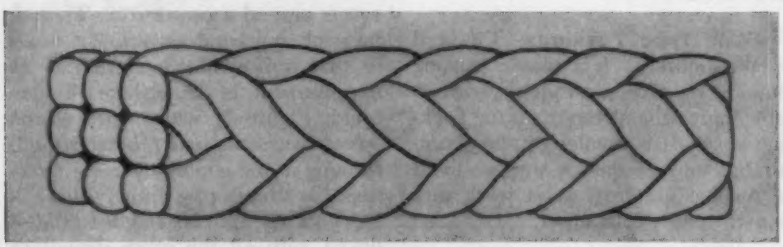


FIGURE 3—Square braid packing provides a better structural bond between the layers.

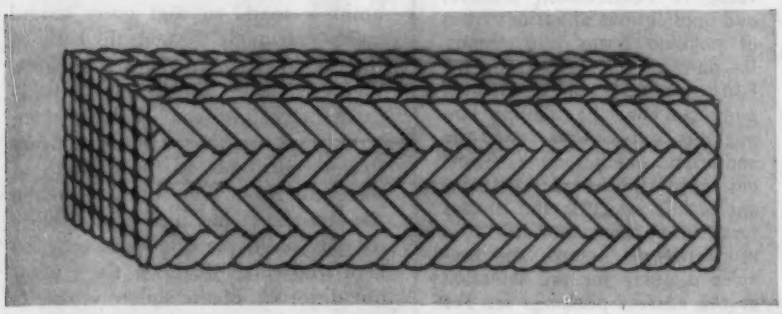


FIGURE 4—Interlocking braid packing provides a unified structure braided internally as well as externally.

ton, rayon, nylon, flax or for water applications, ramie may be used. White asbestos with a mixture of 20 percent cotton for weaving is good for alkaline, neutral or weak acid solutions. Blue asbestos, which is coarse and wears the shaft more than white asbestos, is used without a cotton mixture and is resistant to strong mineral acids.

Metallic braided packing is sometimes the only solution for high temperature applications. It is tough and because it has no resiliency, it cannot handle shaft run-out or whip and it must be well lubricated. Under proper conditions it may wear the shaft less than a fiber packing. An intermediate step is to use a wire-reinforced fiber packing which will impart strength to the fiber strands.

Plastic braided packing of Teflon will show many times the life of other materials in highly corrosive fluids. Since it has a high co-efficient of expansion, a temperature increase may bind it to the shaft. As a suspensoid, Teflon is used to saturate blue and

TABLE 1

Types of Packing to Use With Various Media

Medium	Centrifugal and rotary shafts
Steam High pressure	Asbestos Metallic Semi-metallic Plastic (loose fill)
Steam Low pressure	Asbestos Metallic Semi-metallic Plastic (loose fill)
Water Hot	Asbestos Semi-metallic Plastic (loose fill) Mechanical seals
Water Cold	Asbestos Flax, jute or ramie Cotton or rayon Semi-metallic Plastic (loose fill) Mechanical seals
Gasoline and oils Hot	Asbestos Semi-metallic Plastic (loose fill) Mechanical seals
Gasoline and oils Cold	Asbestos Semi-metallic Plastic (loose fill) Mechanical seals
Air	Asbestos Semi-metallic Plastic (loose fill) Mechanical seals
Gas	Asbestos Semi-metallic Mechanical seals
Acids and caustics	Asbestos (blue) Semi-metallic Plastic (loose fill) Mechanical seals Teflon
Ammonia	Asbestos Semi-metallic Mechanical seals

white asbestos to increase their life against water and acids.

Other binders for fiber type packings are natural or synthetic rubber, mineral or fatty oils, wax, white petrolatum, castor oil, shellac, chlorinated or fluorinated lubricants, high flash mineral oil, glycerin, soap or mixtures.

Woven fibre may be wrapped, accordion folded, laminated or pleated. Generally, it is made as a cloth with cotton, brass, monel or other metal wire reinforcement. Where metal reinforcement is present, it is necessary that hardened or semi-hard shaft sleeves be provided as recommended by the packing manufacturer.

Woven material is porous so it may be impregnated with any of the elements mentioned under braided packing.

Wrapped and accordion folded

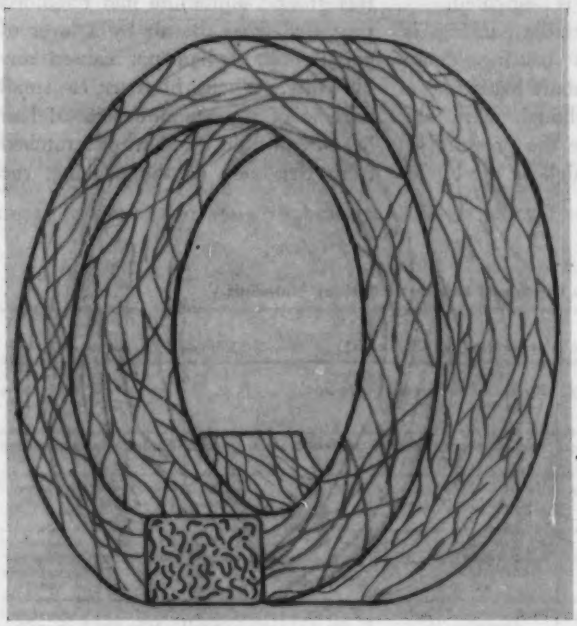


FIGURE 5—Crimped metal packing is made of babbitt lead, copper or aluminum foil ribbons.

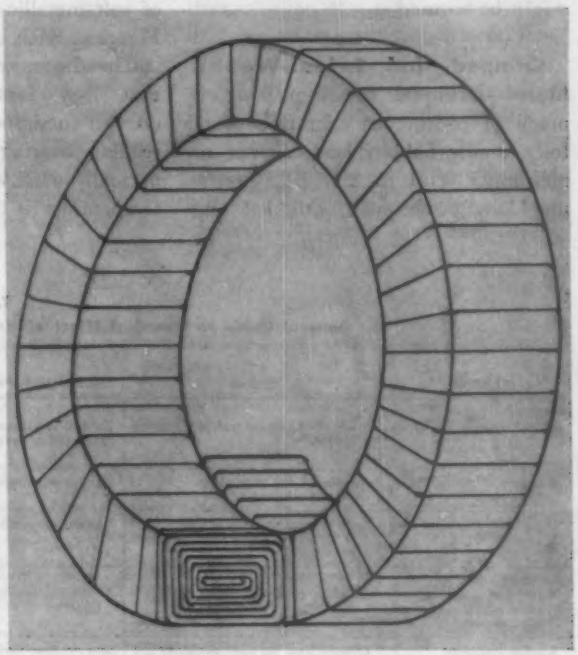


FIGURE 6—Spiral-wound flexible packing consists of layer-over-layer of metallic fold.

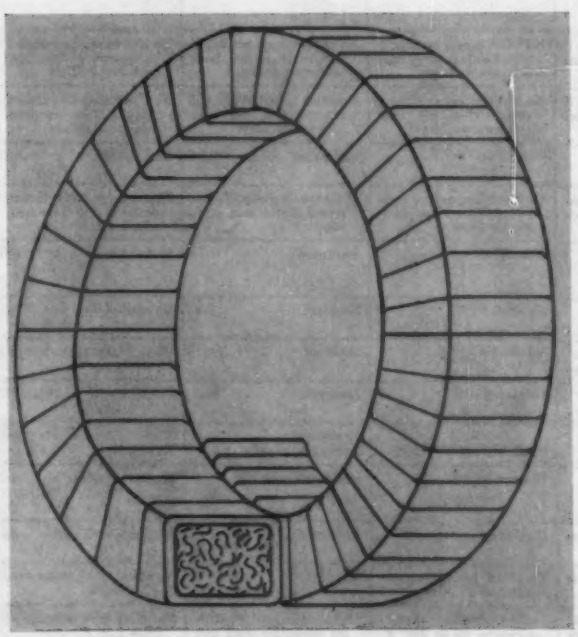


FIGURE 7—Spirally-wrapped packing with a core of lubricated asbestos.

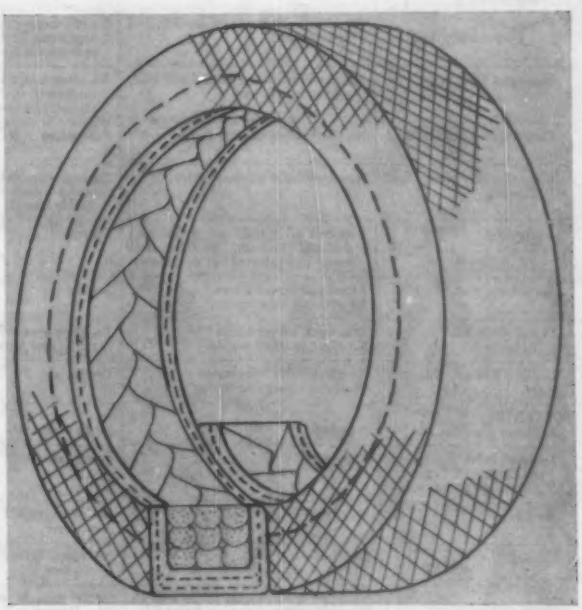


FIGURE 8—Packing with an insert of soft copper wire with a rubber treated, asbestos channel.

cloth is usually cemented with a binder to seal porosity and hold folds together.

Generally, woven fiber packings are not designed for centrifugal pump use, although in an emergency many might be so used.

Crimped and Spiral-Wound Metal—Crimped metal packing is made of continuous thin ribbons of foil, usually babbitt lead, copper or aluminum, (up to 800 F), spirally and loosely wrapped, crinkled and folded and squared to desired size, Figure 5. Each layer of foil is lubricated with an oil or graphite so that the voids form lubrication reservoirs.

Spiral-wound flexible packing is made by spirally wrapping thin layers of soft metallic foil, layer over layer, Figure 6. Each layer is lubricated.

The theory of metallic packings is that they form a bearing dense enough to support shaft loads like a regular bearing although they are normally used where the pressure or temperature is too high or the liquid to corrosive for fiber packing.

Some years ago one refinery fire was reported to the A P I as having been caused by aluminum foil packing.

The theory formulated to describe the sequence of events was as follows: Part of the aluminum foil packing had been ground (by abrasive wear) to a colloidal fineness and so long as this ground aluminum had remained protected from the air by a layer of volatile oil, it had not caused any difficulty. When, however, a small particle of the aluminum metal had been thrown off the shaft or scratched from the body of the packing, the

TABLE 2

General Guide to Chemical Effect of Various Gases and Liquids on Packing Materials.

MEDIUM	Metals	Natural Rubber or GR-S	Neoprene	Buna-N	Thiokol
GASES					
Air or Oxyen up to 700° F..	Little effect (except lead melts above 600° F.)	Hardens or becomes tacky. May ignite in oxygen	Hardens and decomposes at temperatures above 300° F.	Hardens	Volatile at temperatures above 212° F.
Halogens (Chlorine, Bromine, etc.)	No effect if free from water. Otherwise attacked	Hardens on exposed surfaces	Hardens on exposed surfaces	Hardens on exposed surfaces	Hardens on exposed surfaces
Other Hot Gases or Dry Steam	Little or no effect below melting point of metal. Hot compressed hydrogen embrittles steel.	Hardens or becomes tacky	Hardens. Decomposes at temperatures above 300° F.	Hardens	Volatile at temperatures above 212° F.
LIQUIDS:					
Water (including all neutral water-soluble salts, sugar solutions, etc.)	No effect, except iron rusts	No effect except slow swelling	Swells—Especially in fabric constructions	No effect except slow swelling	No effect at temperatures below 212° F. except slow swelling
Alkaline Solutions	Dissolve lead, tin, zinc, aluminum and alloys. No effect on iron, copper or nickel	Slow swelling. Reversion at very high temperature	Swells—especially in fabric constructions	No effect except slow swelling	No effect at temperatures below 212° F. except slow swelling
Weak Acid Solutions (including Acetic and other organic acids, sulphurous acid and low concentrations of sulphuric and hydrochloric)	Little effect on copper and copper alloys. Attack iron (unless chromium alloy). Acetic acid attacks lead. Aluminum resists organic acids only.	No effect except slow swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers
Strong acids Hydrochloric Acid	Attacks all metal except Hastelloy, gold and platinum	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers
Sulphuric Acid	Attacks all metals except Duriron, lead, gold and platinum	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers	No effect except swelling if compound is free from acid-soluble fillers
Concentrated Sulfuric Acid	No effect unless dilution occurs	Carbonized	Carbonized	Carbonized	Carbonized
Concentrated Acetic Acid (Glacial)	No effect unless dilution occurs	Slight swelling only, if compound is free from acid-soluble fillers	Slight swelling only, if compound is free from acid-soluble fillers	Slight swelling only, if compound is free from acid-soluble fillers	Slight swelling only, if compound is free from acid-soluble fillers
Nitric Acid	Dissolves all metals except Duriron, gold and platinum. (Stainless steel resists concentrated but not dilute)	Destroyed	Destroyed	Destroyed	Destroyed
Aqua Ammonia	Attacks all copper alloys. No effect on other metals	No effect	No effect	No effect	No effect
Liquid Ammonia (Anhydrous)	Attacks all copper alloys. No effect on other metals	No effect except from heat and oil asso. with ammonia	No effect	No effect	Little if any effect
Liquid Chlorine, Bromine, etc.	No effect if free from water. Otherwise attacks all metals	Destroyed	Destroyed	Destroyed	Destroyed
SOLVENTS: Aliphatic (Gasoline, etc.)	No effect	Swells excessively	Swells slightly	Swells very slightly	No effect
Aromatic types (Benzol,etc.) or Chlorinated Types (Carbontetrachloride, etc.)	No effect	Swells excessively	Heavy swelling	High swelling	Moderate swelling
Acetone	No effect	No effect except extracts softeners	High swelling	High swelling	Moderate swelling
Alcohol	No effect	No effect except extracts softeners	No effect except extracts softeners	No effect	No effect
OILS	No effect except high-sulphur hot oils attack copper, iron and alloys	Swells strongly with cold oils. Reverts and dissolves with hot oils	Swells moderately at temperatures up to 300° F. Decomposes at higher temperatures	Slight shrinkage or swelling depending upon aromaticity of the oil	No effect at temperatures below 212° F.

dried powder had spontaneously ignited on exposure to the air. As this is the only refinery fire ascribed to this cause, the theory has received little credence.

The substitution of lead and plastic combination packing sets has proven successful for operation below 250 F. But little or no progress has been made in finding a suitable substitute for aluminum in temperatures over 250 F on light hydrocarbon service.

Metal-foil packings are durable but they lack resilience so the shaft or shaft sleeves must run true. Metallic packing must be flexible and compressible. Although it is well saturated with lubricant when being made, it must receive additional lubricant while running either from the liquid being pumped or from an external source through a lantern ring.

The frictional resistance is chiefly from the fluid film so there is less wear than with fiber types.

To improve resilience and increase the lubrication carrying capacity metallic packings are combined with various soft cones. Figure 7 shows a spirally-wrapped, thin ribbon, soft babbitt foil with a core of lubricated asbestos. Figure 8 shows a combination where the core is an insert of soft annealed braided copper wire fastened to an oil-proof, synthetic rubber treated, asbestos channel. This type is used for tar and asphalt centrifugal pumps; but the channel types, with their various core materials, are more generally used with reciprocating pumps.

Table 1 is intended only as a general guide to the chemical effect of various gases and liquids on the materials commonly used in packings. The mechanical properties of the packing are of equal importance so that selection of a packing should not be based solely on chemical consideration.

Table 2 lists the different kinds of packing to use with various media.

ACKNOWLEDGMENT

The information contained in the tables is published through the courtesy of the Garlock Packing Company, Palmyra, New York.

Part 3 will appear in an early issue of Petroleum Refiner.

Silicone	Phenolic Resins	Teflon	Asbestos	Blue Asbestos	Cotton, Flax Viscose Rayon	Paper	Leather
No effect except slow hardening. Decomposes at temperatures above 500° F.	Little effect	No effect	No effect	No effect	Weakens and may ignite above 300° F.	Becomes weak and brittle above 212° F. Ignites in oxygen	Hardens. May ignite in oxygen
Hardens on exposed surfaces	No visible effect	No effect	No effect	No effect	Weakens	Weakens	Hardens
Softens. Decomposes in steam	No effect	No effect	No effect	No effect	Weakens at temperatures above 212°	Becomes weak and brittle at temperatures above 212° F.	Hardens at temperatures above 212° F.
Swells and eventually decomposes-rate depending upon temperature	Very slight swelling	No effect	Tendency to disintegrate in absence of waterproof binder	Tendency to disintegrate in absence of waterproof binder	No effect unless superheated	Disintegrates	Loses waxes. Shrinks and hardens on drying
Swells. Decomposes when solutions are strong and hot	Very slight swelling unless solutions are strong and hot	No effect	Hardened by strong alkalies	No effect	Destroyed by strong, hot alkalies	Destroyed	Destroyed
Swells and eventually decomposes	No effect except slight swelling	No effect	Very little effect	No effect	Weakens	Destroyed	Loses waxes. Shrinks and hardens on drying
Swells. Rapid decomposition	No effect except swelling	No effect	Hardens and partially dissolves	No effect	Destroyed	Destroyed	Fairly resistant
Swells. Rapid decomposition	No effect except swelling	No effect	Hardens and partially dissolves	No effect	Destroyed	Destroyed	Fairly resistant
Carbonizes	Carbonized	No effect	No effect unless dilution occurs	No effect	Destroyed	Destroyed	Destroyed
Slight swelling	Very slight swelling	No effect	No effect	No effect	No effect	No effect	No effect
Destroyed	Destroyed	No effect	Hardens and partially dissolves	No effect	Destroyed	Destroyed	Destroyed
Swells and eventually decomposes	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Little effect	No effect	No effect	No effect	No effect	No effect unless heat is present	Little effect if any	No definite data
Destroyed	Destroyed	No effect	No effect	No effect	Destroyed	Destroyed	Destroyed
Slight swelling	No effect	No effect	No effect	No effect	No effect	No effect	Loses waxes, shrinks and hardens
Swells excessively	Very slight swelling	No effect	No effect	No effect	No effect	No effect	Loses waxes, shrinks and hardens
Little effect	Slight swelling	No effect	No effect	No effect	No effect	No effect	Loses waxes, shrinks and hardens
Little effect	Slight swelling	No effect	No effect	No effect	No effect	No effect	Loses waxes, shrinks and hardens
Moderate swelling	No effect	No effect	No effect	No effect	Weakens at temperatures above 212° F.	No effect at temperatures below 212° F.	Loses waxes and tends to become porous. Hardens at temperatures above 212° F.

Chinese Use Brackets

You don't have to worry about different size pipe flanges not matching. The Chinese on Formosa don't, and you'll find out why when you read this interesting and informative "How To Do It."

Keep Going to Page 182.

What, Where, and When

A "must read" for every man in the industry is PETROLEUM REFINER's "Meetings Calendar." It's an easy-to-read tabulation of what's coming up in the societies and associations that are of most interest to you.

Keep Going to Page 251.

API'ers To Philly

The API Division of Refining has released the program for its semi-annual meeting in Philadelphia, and its all there for you to read in this months account of "What's Happening in the Industry."

Keep Going to Page 233.

Keep Up With People

Be sure to check through "Men In Industry" to see what's happening to people you know—and those you would like to know."

Keep Going to Page 254.

My! How Times Do Change

They certainly do! And that's why you should read "Changing Times," the fast-moving account of those items that made news in the industry last month. Its just what the doctor ordered for busy industry men who don't have time to wade through paragraph after paragraph to get the meat of a subject. See for yourself!

Keep Going to Page 249.

Due-On Stream

This month's building section is highlighted by the story of Celanese Corp. of America's new ethylene polymer plant which is scheduled to go on stream this month near Houston. For more information about this new plant plus the latest information of many other construction projects from all over the world, be sure to read "Who's Building."

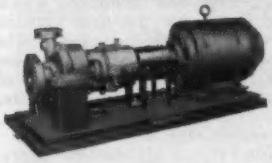
Keep Going to Page 191.

You Should Know

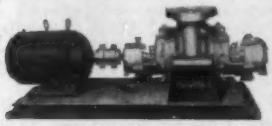
Information you need to know about the companies which service and supply the refining-petrochemical-natural gasoline industry will be found in "What Suppliers Are Doing." This department will help you keep up with the people who serve your plant, and any extension of facilities or services which may be of benefit to you.

Keep Going to Page 267.

AN I-R PUMP FOR EVERY REFINERY APPLICATION

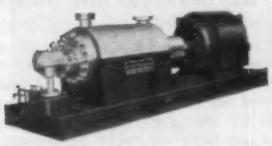


Single stage, vertically split—20-3200 gpm, heads to 600 ft.



Single and two stage, vertically split —20-3500 gpm, heads to 1100 ft.

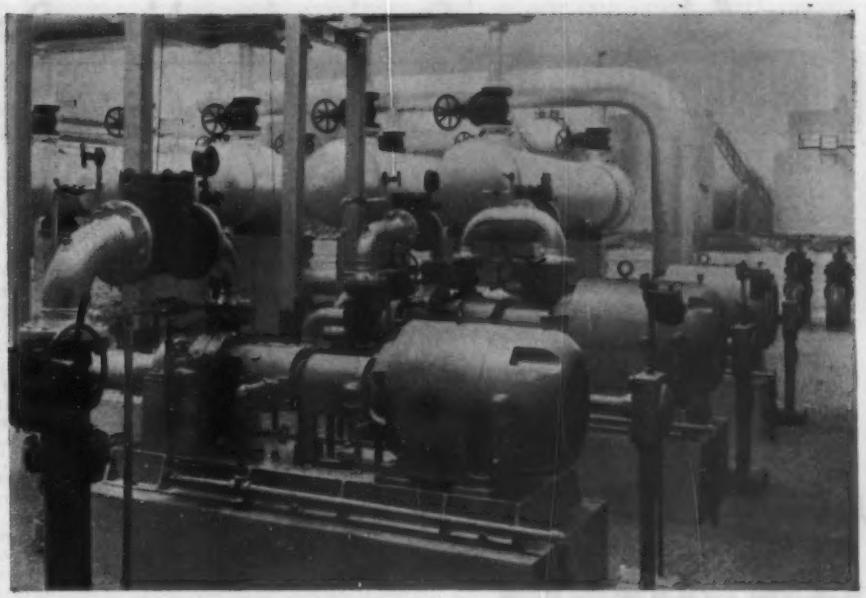
Single stage, vertically split—200-7000 gpm, heads to 225 ft.



Multi-stage horizontal diffusor type —450-3000 gpm, heads to 6000 ft.

Multi-stage vertical diffusor type— 20-400 gpm, heads to 4800 ft.

Single or multi-stage vertical turbine pumps—60-35,000 gpm, heads to 150 ft. per stage.



How IR refinements in pump design mean long range savings in REFINERY SERVICE

What determines your choice when selecting a pump for a given job?

You want the pump that gives you the *most* for the money—the most *dependable* service, highest *sustained* efficiency, and lowest year-after-year maintenance cost. And all these result from refinements in pump design and manufacture.

In all I-R process pumps, these refinements have been carried to the fullest extent. Unsurpassed metallurgical facilities assure proper material selection and heat treatment of all pump parts to meet actual service conditions to best advantage. Casings, impellers, wearing rings, shaft sleeves are built of materials formulated to minimize the effects of corrosion, erosion, expansion and thermal shock.

Running clearances of all moving parts are proportioned not just for a high initial efficiency, but for maximum sustained efficiency year after year. Easier accessibility for inspection or servicing cuts down-time. Extensive interchangeability of parts throughout the entire I-R line simplifies stocking of replacement parts.

Your Ingersoll-Rand representative will be glad to give you the complete story on the extra-value features of any I-R pump. His specialized design and application experience can save you time and effort on any job.

Ingersoll-Rand

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For more data on advertised products, use Readers' Service Cards, last page.

CORROSION
ABRASION
BLINDING

Successful processing work such as filtering and straining depends on the accuracy of openings and proper selection of metals, woven to exact job specifications.

We fabricate filter segments and strainer elements to your individual job requirements in plain or twilled weaves, cabled, single, dutch, or corduroy. Openings range from 6" clear to .0017". Available in all commercial metals and alloys such as stainless, steel, monel, silver, and copper alloys.

Send us your job requirements, our complete sample service is at your disposal.

Write for Bulletins 6, 7, 8

The CLEVELAND
WIRE CLOTH & MFG. Co.
3578 E. 79th Street
Cleveland 5, Ohio

Reviewing New Books . . .

Flow of Gases Through Porous Media by P. C. Carmen, provides an account of the flow processes involved when gases flow into or through finepores. It has been designed for readers requiring a connected account of our present state of knowledge on the subject, discussing both theory and experimental methods, rather than those interested in specific technical applications.

The subject is approached from the view-point of the Kozeny theory, and its limitations are fully discussed. It is extended to cover Knudsen flow, and to the transition from viscous to turbulent flow. Its application to the permeability method for measurement of surface powders is fully described.

In addition, recent work on surface diffusion and capillary flow of absorbable gases in fine-pored systems is reviewed for the first time. A chapter on the uses of porous media for gas separations includes a discussion of gas chromatography.

(Academic Press Inc., Publishers, 111 Fifth Ave., New York 3, N. Y., $6.00. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas.)

C.R.C. Standard Mathematical Tables succeeds the former Mathematical Tables which was in its ninth edition. In this new book of tables, the modern trend for work-saving and time-saving helps has been recognized.

In this book, the integral tables have been completely revamped and now include approximately 100 additional formulas which should greatly enhance their application and convenience. Also, the "Operational Method" in the field of calculus implies a procedure for solving differential equations wherein boundry or initial conditions are automatically satisfied in the course of the solution.

Included also for the student of statistics is an "F and t table" for distributions of one percent and five percent, a Chi square table and other important reference materials, and tables particularly suited for those in the field of statistical analysis.

(The Chemical Rubber Co., 2310 Superior Ave., Cleveland 14, Ohio, $3.00 and $3.50 outside U.S.A.)

Polyarylurea Greases by D. T. Kjerland, Wright Air Development Center. July 1956. In previous research, arylurea compounds with good grease thickening characteristics were prepared from aromatic isocyanates or aromatic diisocyanates and an aromatic amine or combination of aromatic amines. This report deals with formation of polyarylurea greases through use of aromatic diamines and aromatic diisocyanates as reactants. Preliminary data showed polyarylureas to have much better thickening ability than simple arylureas with equivalent heat stability.

(Order PB121531 from OTS, U. S. Department of Commerce, Washington 25m D. C., 19 pages, 50 cents.)

1956 Supplements to Book of ASTM Standards are issued in seven parts and give in their latest form, 420 specifications, tests, and definitions which were either issued for the first time in 1956, or revised since their appearance in the 1955 book. The ASTM issues these supplements to each part of the Book of ASTM Standards to keep them up-to-date. The new parts are as follows:

Part 1. Ferrous Metals—440 pages.

Part 2. Non-Ferrous Metals—360 pages.

Part 3. Cement, Concrete, Ceramics, Thermal Insulation, Road Materials, Waterproofing, and Soils—300 pages.

Part 4. Paint, Naval Stores, Woods, Sandwich Construction, Building Constructions, Fire Tests, Wax Polishes—230 pages.

Part 5. Fuels, Petroleum, Aromatic Hydrocarbons, Engine Antifreezes—320 pages.

Part 6. Rubber, Plastics, Electrical Insulating Materials—380 pages.

Part 7. Textiles, Soap, Water Paper, Adhesives, Shipping Containers, Atmospheric Analysis—220 pages.

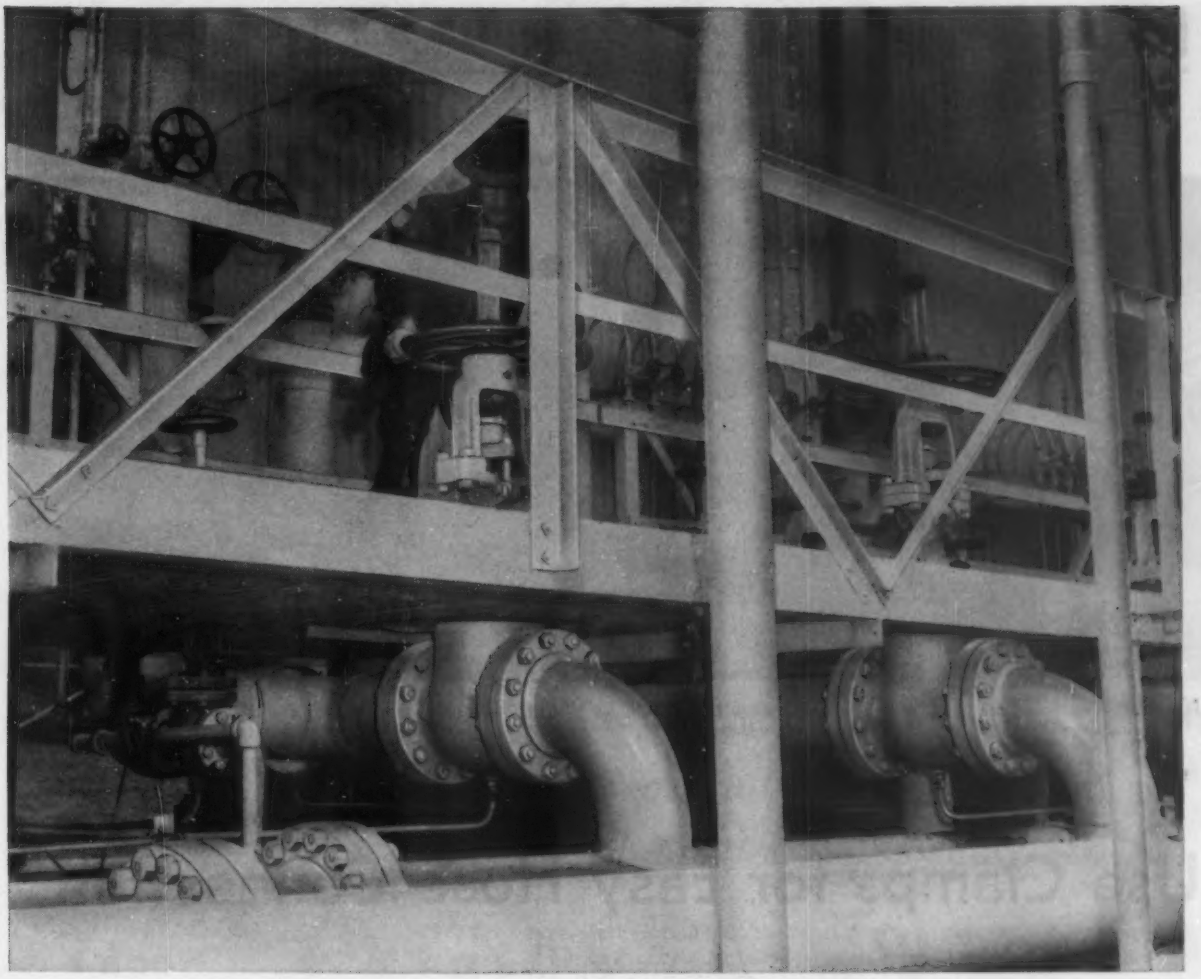
(American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., $4.00 per part or $28.00 for all seven parts.)

Details of Natta (Montecatini) Olefin Polymerization Techniques. Several recently authorized Irish patents are available which give what is believed to be the most thorough and up to date account of the processes used in the manufacture of isotactic polymers of olefins and diolefins by the so-called Natta technique. These are believed much more comprehensive and thorough than any Italian or Belgian patents issued to Professor Ziegler or the Montecatini Co., and have the advantage of being in the English language. Since Irish patents are not printed copies can be obtained through government channels in Dublin only after considerable delays. The Irish patent office does not employ a photocopying machine, and all copies must be typed by hand. Now, however, photostats of the following patent specifications are available immediately.

1. Irish Patent #33855 issued to Montecatini and Ziegler entitled "Complete Specification; Crystalline, Linear High Polymers." $45.00.
2. Irish Patent #39955 issued to Montecatini and Ziegler entitled "Complete Specification; Production of Linear High Polymers of Regular Structure from Alpha-Olefines." $65.00.
3. Irish Patent #42555 issued to Ziegler and Montecatini entitled "Process for Polymerization of Olefines and Solid Polymers of Olefines." $45.00.
4. Irish Patent #66855 issued to Montecatini and Ziegler which is an extremely comprehensive specification with 46 examples, entitled "Process for Selective Polymerization of Alpha-Olefines into Crystal or Amorphous Polymers" and dealing primarily with polypropylene. $120.00.

(Chemonomics, Inc., 270 Park Avenue, New York 17, N. Y. Mailed immediately after receipt of company purchase order.)

For more data on advertised products, use Readers' Service Cards, last page.



Double Block Protection at Half the Cost —with Crane Flexible Wedge Disc Gate Valves

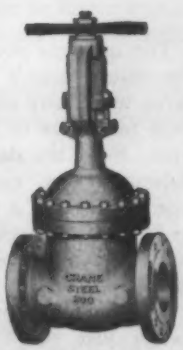
There are real savings in this installation.

The main valves you see in the photo are Crane 33XU steel gates modified with flexible disc—8-, 6- and 2-inch—on the dehydrator in the Phillips Pipeline Company pump station at Borger, Texas. Moisture is removed from the product here, using butane at 450° F. The setup is part of Phillips' 8-inch Borger-Chicago product pipeline, looped in 1951 to handle dissimilar products.

Design features of the Crane flexible wedge disc gate valves are cutting costs across the board. With the flexible disc, positive seal is assured on the upstream as well as downstream side. Each valve does the work of two with solid wedge disc.

Tapped opening is provided in bottom of body which permits bleeding while main valve is closed. Valve and piping costs are cut in half; the operator has only one valve to handle instead of two.

Crane flexible wedge disc steel gate valves can be furnished in sizes 2- to 12-inch, pressure classes up to 1500 lb. Get the facts from your local Crane Representative, or write to address below.



CRANE VALVES & FITTINGS

PIPE • KITCHENS • PLUMBING • HEATING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

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How To Do It . . .

FIGURE 1—The steam hose flange cannot be connected to the car pipe leg since the number of bolt holes on each is different.

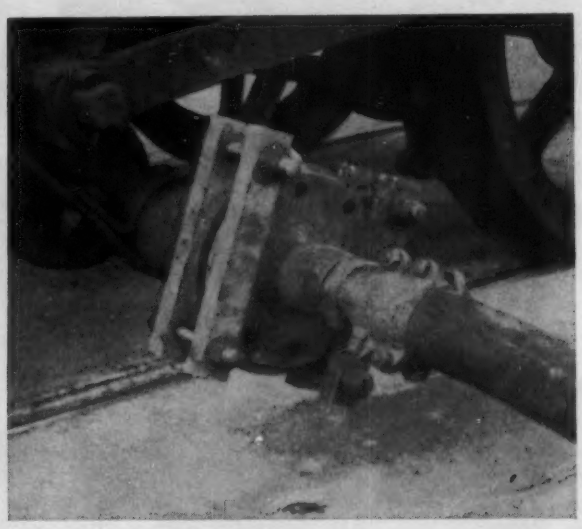


FIGURE 2—By using these clamps and a gasket, the misalignment of bolt holes is of no consequence.

Use Clamps for Easy Hose Connection

You can lick the problem of 'flanging-up' different size pipes . . . and here's how!

This idea was submitted by:
Yang Tzen-yung
Maintenance Division
Kaohsiung Refinery
Chinese Petroleum Corp.
Kaohsiung, Taiwan

The tank car shop, of the Chinese Petroleum Corp.'s refinery on Formosa, uses steam and water to purge their tank cars of vapor preceeding repair. Since the shops handle several classes of cars, each with its own type of pipe leg, a number of reducers and pipe flanges were required to assure matching the car's companion flange.

Recently, the routine of matching flanges was simplified by using a clamp to connect the various flanges directly without resorting to reducers or pipe joints.

The flange clamp is made of twin, rectangular bars, each of which is 11¾ inches by 1¾ inches by 1¼ inches. They are bolted together with two ¾-inch by 6-inch bolts, spaced 8 inches on centers.

The connection is made by placing the flanges face to face and inserting a gasket. The fact that the flanges may be of different sizes is disregarded. Two sets of clamps are placed on opposite sides of the flanges, parallel with each other. The clamp nuts are then tightened uniformly.

This coupling arrangement may be adapted to a number of other temporary services, such as, air blowing, steam purging, water feeding, sewage drainage and bulk loading, all of which are operated under moderate pressure.

Catalyst Look Box

One of the big disadvantages in most refinery process equipment is that the operator can not see what is going on inside the lines and vessels. Usually he can rely on instruments to keep him informed, but in one particular instance it was found helpful to provide a "look box." On this cat cracker, fresh catalyst is pressured to the lift engager three times daily. Operators depended on listening with their ear against the pipe to determine when the fresh catalyst was flowing. Of course this is not completely satisfactory so a clear plastic window was installed on

It's NEW! It's Revolutionary!

Ever see a steam trap

SO SMALL

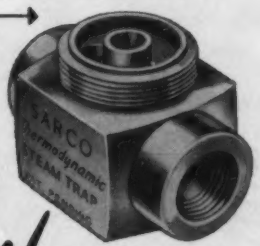
SO SIMPLE

SO TROUBLE-FREE!

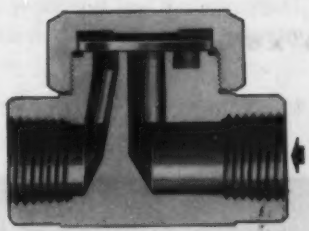
1. A CAP

2. A DISC

3. A BODY



That's all!



YES, SO TROUBLE-FREE: No valve-closing mechanism to wear or stick – the kinetic energy of steam closes valve. No critical clearances to choke. No gaskets to leak.

Practically Eliminates Maintenance!

Here's the *smallest*...the most *compact*...the most *durable* steam trap you've ever seen...for all-around trapping effectiveness! It's the new Sarco Thermodynamic trap.

Look at it. So small...it fits into the hollow of your hand. So simple...only 3 rugged parts...machined from stainless steel bar stock. So trouble-proof...only moving part, a hardened solid stainless steel disc, practically immune to wear. Not affected by superheat, water-hammer, corrosive condensate.

Use the SAME trap for 10-600 psi...for light or heavy loads ...without seat or valve change or other adjustments. Closes tight on no load—no steam waste.

Ask for a 60 day trial installation of Sarco TD trap and strainer...write for bulletin 257. Sarco Company, Inc., Empire State Bldg., New York 1, N. Y.

2140-B

SARCO

Only Sarco Makes All 5 Types

That's why Sarco can give impartial advice on proper steam trap selection.

For more data on advertised products, use Readers' Service Cards, last page.

New Taylor TRAN

Gives Superior

Taylor Instruments

For more data on advertised products, use Readers' Service Cards, last page.

SCOPE* Controller

Performance in a Small Package

Latest addition to famous Transet line uses unique Motion-Balance principle. Proven by months of tests on toughest applications.

HERE'S the first in a series of new Taylor TRANSCOPE instruments that will set new standards of process control performance. It's the new TRANSCOPE Controller—a miniature controller that's new in design, new in principle . . . and in performance has no equal, particularly on applications where the span of measurement is very short. It is ideal for the time constants of modern processing.

Simple to adjust, easy to maintain—and to convert from one form of control to another, the TRANSCOPE Controller can be panel, rack or field mounted. The adjustable proportional response system is based on the Motion-Balance principle that uses bellows as pressure sensitive elements. The illustration on the opposite page shows how the instrument looks—here's what it means in your plant:

1. Exceptionally fast and smooth response—particularly important on start-ups.

2. Ease of alignment—smooth-acting screw-driver adjustment because of ball-bearing construction.

3. New high standard of accuracy and setting for gain, reset and Pre-Act responses.

4. Outstanding in its insensitivity to ambient temperatures.

5. Very low air consumption—only 0.1 scfm.

6. Adaptability to changes in process requirements . . . complete interchangeability of components so you can convert from simplest to most complex forms of control *in the field.*

7. Instrument action is reversed by merely rotating a dial.

8. Integral cut-off relay—a *built-in feature*—for field-mounted or panel-mounted use.

9. Plugs into Transet Indicators or Recorders or locally-mounted manifolds.

10. Friction-free bending member . . . no maintenance because no wear.

11. Easy access to nozzle and baffle.

12. Rugged bellows construction keyed in position. Dynamically-balanced force plate.

13. Stainless steel nozzle and baffle . . . hardened stainless reaction members . . . rugged aluminum assemblies. Dust and moisture-proof case suitable for outdoor mounting.

Write for Bulletin 98278.

• • •

Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

*Trade Mark

MEAN ACCURACY FIRST

For more data on advertised products, use Readers' Service Cards, last page.

you can meet any lubrication standard if you

BLEND WITH ENJAY PARATONE®

(VISCOSITY-INDEX IMPROVERS)

Base stocks blended with Enjay Paratone can be compounded into lubricants combining cold-weather quick starting properties with high temperature, low consumption characteristics. These lubricants are *all-season* oils, featuring improved gas mileage. More and more refiners and blenders are relying exclusively on Paratone to produce the high "VI" required in these all-season oils.

Through years of intensive research and development work with automotive manufacturers, Enjay has developed the only *complete line* of high quality additives (Paramins®) that can assure *maximum* performance characteristics. Why not let this experience and know-how work for *you*? Write, wire or phone the Enjay Company today.

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Akron • Boston • Chicago • Los Angeles • New Orleans • Tulsa

How to Do It . . .

the line. The accompanying picture shows the excellent application of the device. The window has been in service for several months without appreciable scratching of the plastic service.

Loading Rack Vapor Recovery System

If your company has had difficulty in impeding hydrocarbon emissions to the atmosphere, take a look at the

GET 99.9% EFFICIENT

VAPOR LIQUID

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SEPARATION

with "Schuylernit" Mist Eliminators

By the clean, highly efficient separation of entrained liquids from any gas or vapor, "Schuylernit" Mist Eliminators stop costly liquid loss . . . improve product quality . . . increase Chemical and Petroleum vessel performance.

ENGINEERS . . . send for NEW 16 page illustrated manual describing "Schuylernit" Design, Construction and Performance.

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specialists in liquid/vapor separation

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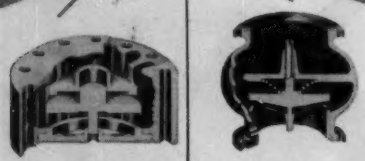
MANUFACTURING CORP., NO. ARLINGTON, N. J.

THESE VALVES
control
surge
pressures
silently



Center-guided type for lines from 1" to 10".

Globe-type for lines from 3" to 24".

WILLIAMS·HAGER
FLANGED
Silent
CHECK VALVES

Surge pressures . . . and the resulting water hammer . . . are effectively controlled by these valves. Protection for pumps and piping systems is assured—a fact testified to by satisfactory service in every type of industry over a period of 28 years, in pressures up to 5,000 pounds.

Write for Bulletins:
No. 654 on the Valves
No. 851 on Cause, Effect and Control of Water Hammer

THE WILLIAMS GAUGE CO., INC.
151 Stanwix Street
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Our 71st Year • 1886-1957

How to Do It . . .

vapor recovery systems installed at these loading racks.

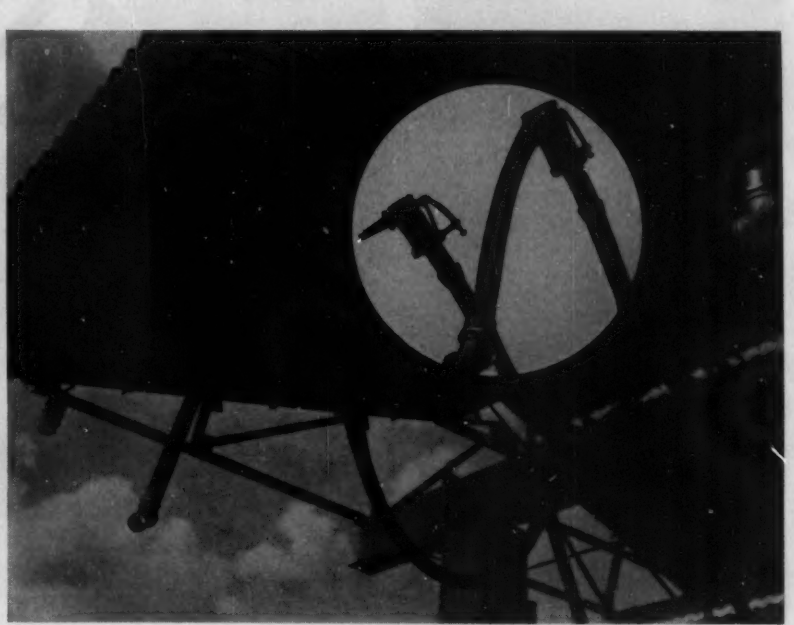
The systems consist of three major parts:

Vapor Collection Head—This device fits on the fill spout at the loading rack. When the fill spout is put into an empty tank truck compartment, the vapor collection head fits securely into the loading aperture. A neoprene collar on the head forms a vapor tight seal. As fuel moves into the empty compartment, it displaces vapor-laden air which moves upward into the vapor collection head.

Compressors—Two compressors keep a constant vacuum on the lines leading from the vapor collection head. This suction pulls the vapors through the lines leading away from the loading rack. The vapors pass through vessels where liquids are separated out and reclaimed for processing. The remaining gases are then pushed into the fuel system of the refinery.

Piping—A network of pipes connects the vapor collection head with the compressors and connects the compressors with the fuel system of the refinery. Each installation involves about 3000 feet of large-size pipe.

These vapor recovery systems will keep a total of 1134 gallons per day of evaporated gasoline from entering the atmosphere. This is approximately .0016 percent of the total volume of gasoline loaded each day at the two loading racks.



Prevent Evaporation Losses

From both the safety and economy point of view, it is desirable to prevent splashing and foaming when loading gasoline trucks. The accompanying photo shows a very inexpensive but effective way to do just that.

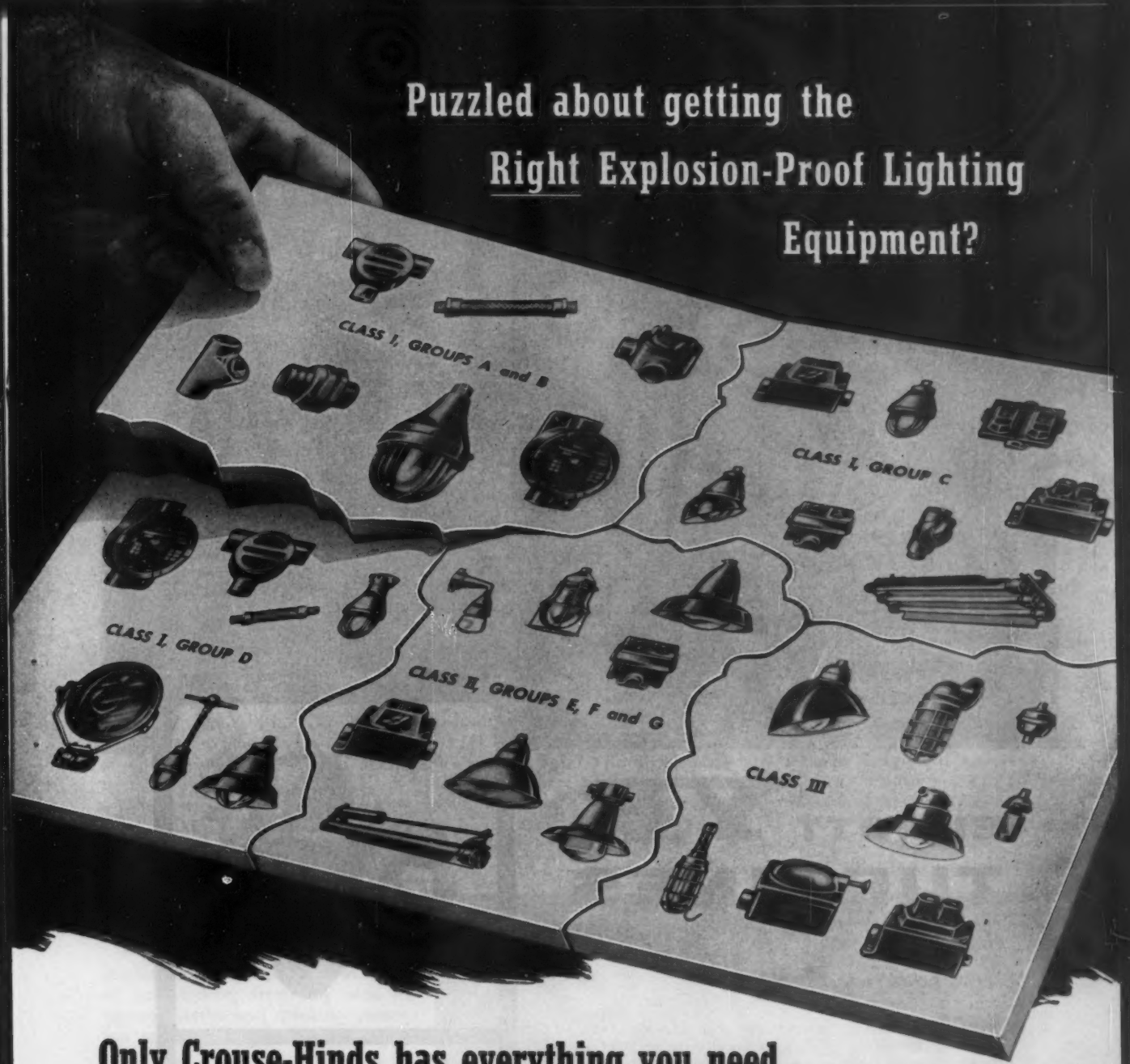
The circled portion of the illustration shows the conventional nozzle (center), with the improved version on the right. The improvement consists simply of a five-foot section of hose with a brass tee on the end, attached to the nozzle. The extension is long enough to allow the tee to rest on the bottom of the tank truck. This eliminates the fire hazard and evaporation losses from the splashing that accompanies loading straight from the nozzle.

It seems mighty simple and you may have already thought of it. If you haven't, you can convert your loading nozzles at a cost of about $10 each.

YOUR IDEAS ARE VALUABLE!

At least $10 will be paid for each idea accepted for "How to Do It." Just send a brief note with a photo or sketch to the Editor, *Petroleum Refiner*, P. O. Box 2608, Houston.

Puzzled about getting the Right Explosion-Proof Lighting Equipment?



Only Crouse-Hinds has everything you need

...in every class ...in every group!

For *complete* protection when making lighting installations in hazardous locations you need more than explosion-proof or dust-tight lighting fixtures. You also need UL-listed explosion-proof switches, junctions, fixture supports, unions and seals.

Crouse-Hinds now offers a broad selection of Condulet* explosion-proof lighting equipment for Class I, Groups A and B locations. In fact, you can specify complete Crouse-Hinds explosion-proof lighting installations, all UL-listed, *no matter what class or group of Article 500 of the National Electrical Code is involved.*

The same holds true for the entire Crouse-Hinds Condulet line of more than 15,000 conventional and explosion-proof items. With the broadest line in the field, Crouse-Hinds recommends *exactly* what you need . . . and *only* what you need.

A nearby Crouse-Hinds distributor will be glad to discuss your explosion-proofing problems and make recommendations without obligation.

NATIONAL ELECTRICAL Week • FEB. 10-16, 1957

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serve refineries everywhere

When it comes to prime movers for process and water pumps, fans or compressors, Elliott mechanical drive turbines are the simple and reliable solution. Elliott single-stage turbines, ranging in size from 2 to 600 hp, are specifically designed to provide highest quality and long-term continuous service. In the cat cracker above, a southwestern refinery, 75 Elliott turbines furnish dependable driving power—24 hours a day.

The Elliott YR turbine design also permits easy inspection, simple replacement of wearing parts, and interchangeable components from one turbine frame to another. What's more, your local Elliott field engineer is always available for application engineering or for operating or maintenance assistance. Call today, or write Elliott Company, Steam Turbine Division, Jeannette, Pa. Ask for Bulletin H-22B.

6 design features you get with ELLIOTT YR single-stage turbines

- True Centerline Support for precise alignment, cold or hot, simplifies installation.
- Weather-Proofed, Reliable Governing System with separate overspeed trip and valve.
- Liner Type Bearings, easy to inspect or replace, rapid heat transfer to cooling oil, sealed against elements.
- Accessible Shaft Seals. Covers—not part of turbine casing—are easily removed for inspection or ring replacement.
- Self-Locating Rotor drops into position without adjustments. Entire rotor is dynamically balanced.
- Interchangeable Components permit interchanging of parts between turbine frame sizes, eliminates need for large inventories.

M7-1

ELLIOTT Company

Steam Turbines • Motors • Generators • Deaerating Heaters • Ejectors • Condensers • Centrifugal Compressors • Turbochargers • Tube Cleaners • Strainers

Who's Building . . .

Next Construction Boxscore to appear in April issue.

New Celanese Plant to Go On-Stream

Low-pressure polyethylene from Houston plant promises to exhibit desirable qualities.

A NEW PLANT BY CELANESE CORP. of America that will make polyolefin resins at the rate of 40 million pounds a year will be placed on-stream this month at Houston. A semi-works unit has been in operation for some time.

Bjorn Andersen, Celanese vice president and general manager of its Plastics division, says the new resin called Fortiflex, will open up entirely new fields for plastics and is capable of substantially improving the qualities of many existing items.

The new resin, made under license from Phillips Petroleum Co., is an ethylene polymer and a member of a new group of plastics sometimes referred to as "low-pressure polyethylene," which represent a major new plastics development.

Products made of this resin will resemble in some respects those made of polyethylene, frequently seen in squeeze bottles and drinking glasses, but will provide properties enabling it to be used in many fields now barred to polyethylene. These products, he said, will have a combination of rigidity, heat resistance, toughness and chemical inertness. They will withstand prolonged exposure to live steam, but will not become brittle even at - 180 F.

Current research indicates the likelihood of future modification of the basic properties of the new resin. As market needs develop, this ability to modify properties will result in the development of a family of polyolefin resins with performance characteristics fitting them to a variety of processes and fabricating applications.

Located on a 220-acre site south of San Jacinto State Park, and near the Houston Ship Channel, the Celanese plant will ship most of its resin by water. Trailer trucks will haul the resin from the plant to the Channel docks where the trailers will be detached for trans-shipment by boat, either direct to customers or to Celanese distribution centers. The plant's entire production will be shipped in molding pellet form for injection and extrusion molding.

Calcasieu Chemical States New Ethylene Glycol Plant

Calcasieu Chemical Corp., New Orleans, will build a new $11 million petrochemical plant at Lake Charles, La. The facility will produce ethylene oxide and ethylene glycol using as raw

The entire production of low pressure polyethylene from this new plant will be shipped in pellet form.

material, ethylene supplied by Petroleum Chemicals, Inc., who will also engineer, build, and operate the plant for Calcasieu.

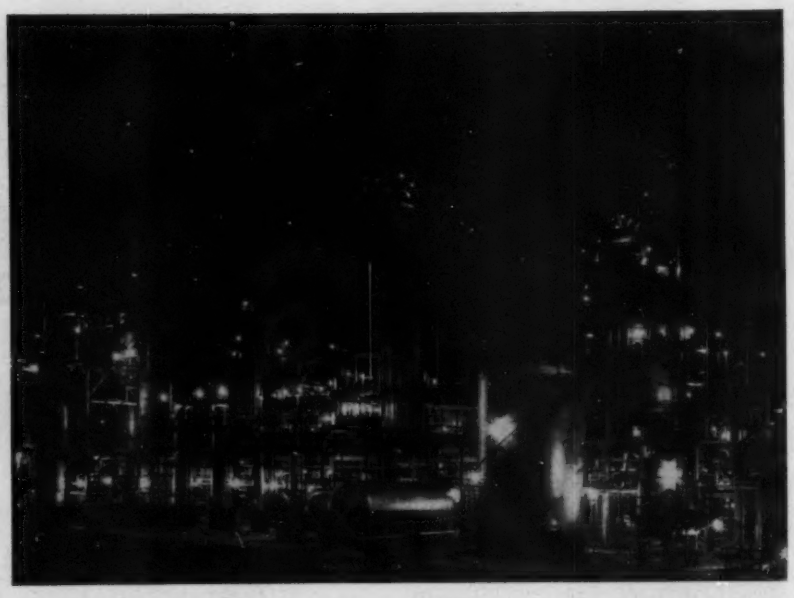
Announcement of the project was made jointly by R. E. Brooker, president of Calcasieu, and Bruce K. Brown, president of Petroleum Chemicals. Brooker is vice president of Sears, Roebuck & Co. which is one of the stockholders of Calcasieu. Other stockholders are Mineral Solvents Co., Chicago, Cities Service Co. and Continental Oil Co.

The Calcasieu plant which will have a yearly capacity of 8 million gallons of ethylene glycol, will be located immediately adjacent to the ethylene plant now under construction by Petroleum Chemicals. The ethylene plant will obtain the refinery gases which it uses as a raw material from the adjacent refineries of Cities Service and Conoco.

Since Calcasieu's stockholders market an ethylene glycol antifreeze, they will draw their supply from the new plant when it is completed. The facility, which is being constructed by Lummus Co., will use a process licensed by Shell Development Co. Construction is beng carried out under the direction of Petroleum Chemical executives from its general offices in New Orleans. Current plans call for completion in early 1958.

Macco Corp. has been awarded a contract by Douglas Oil Co. of California for the engineering and construction of a Unifining process unit at the Douglas refinery at Bakersfield, Calif. The plant will substantially expand Douglas' capacity for producing high-octane fuels. Engineering and construction will be handled by the Refinery and Chemical division of Macco Corp.

National Cylinder Gas Co. will expand its hydrogen production facilities at its Kenosha, Wis. plant. Present plans call for production to be increased by approximately 30 percent.



Night Scene at Tidewater

Shown in this night-time shot is Tidewater Oil Co.'s 130,000 bpd crude unit, the largest of its kind in the world. The Delaware Flying A refinery is scheduled to begin full operations in the early spring.

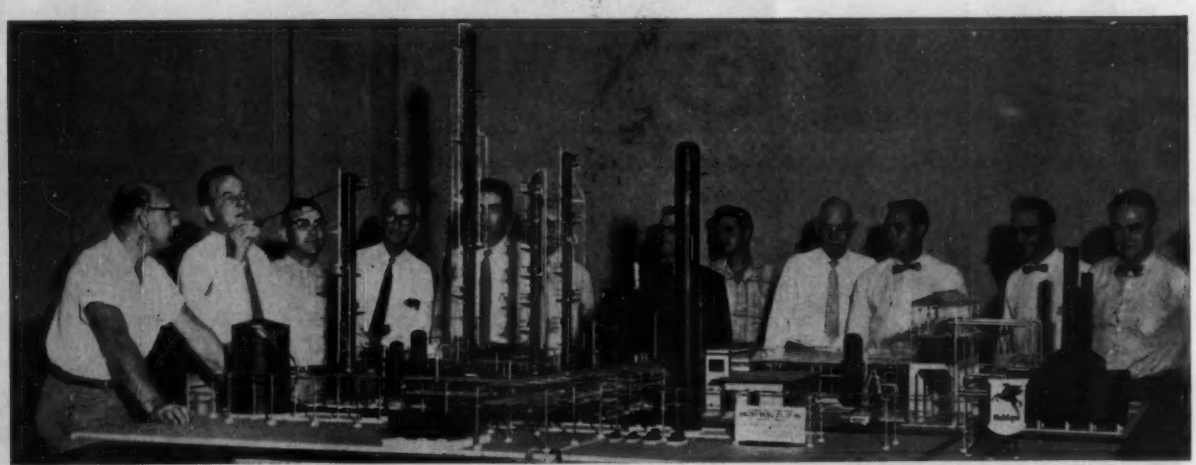
Empresa Nacional De Petroleo is reportedly considering building a small refinery at Caleta Clarencia (near the Straits of Magellan) Cuba with a planned output of 2500 bpd.

Ruhrbau Mineraloelraffinerie G.m.b.H., Muelheim, Germany, is considering building a new refinery with an annual crude throughput of 1 million tons. Negotiations for a suitable site are still underway, but it will be located in the general area of Duisburg, Germany. Operations will be continued at the present facilities at Muelheim. Ruhrbau is owned 75 percent by Petrofina, and 25 percent by Farbenfabriken Bayer A. G.

Petroleum Chemicals, Inc., will build a plant to produce butyl rubber at Lake Charles, La. Announcement came from Bruce K. Brown, president, who stated that an initial plant capacity of 30,000 tons a year would be installed at a cost of over $17 million, and that capacity could easily be expanded by 50 percent at a later date.

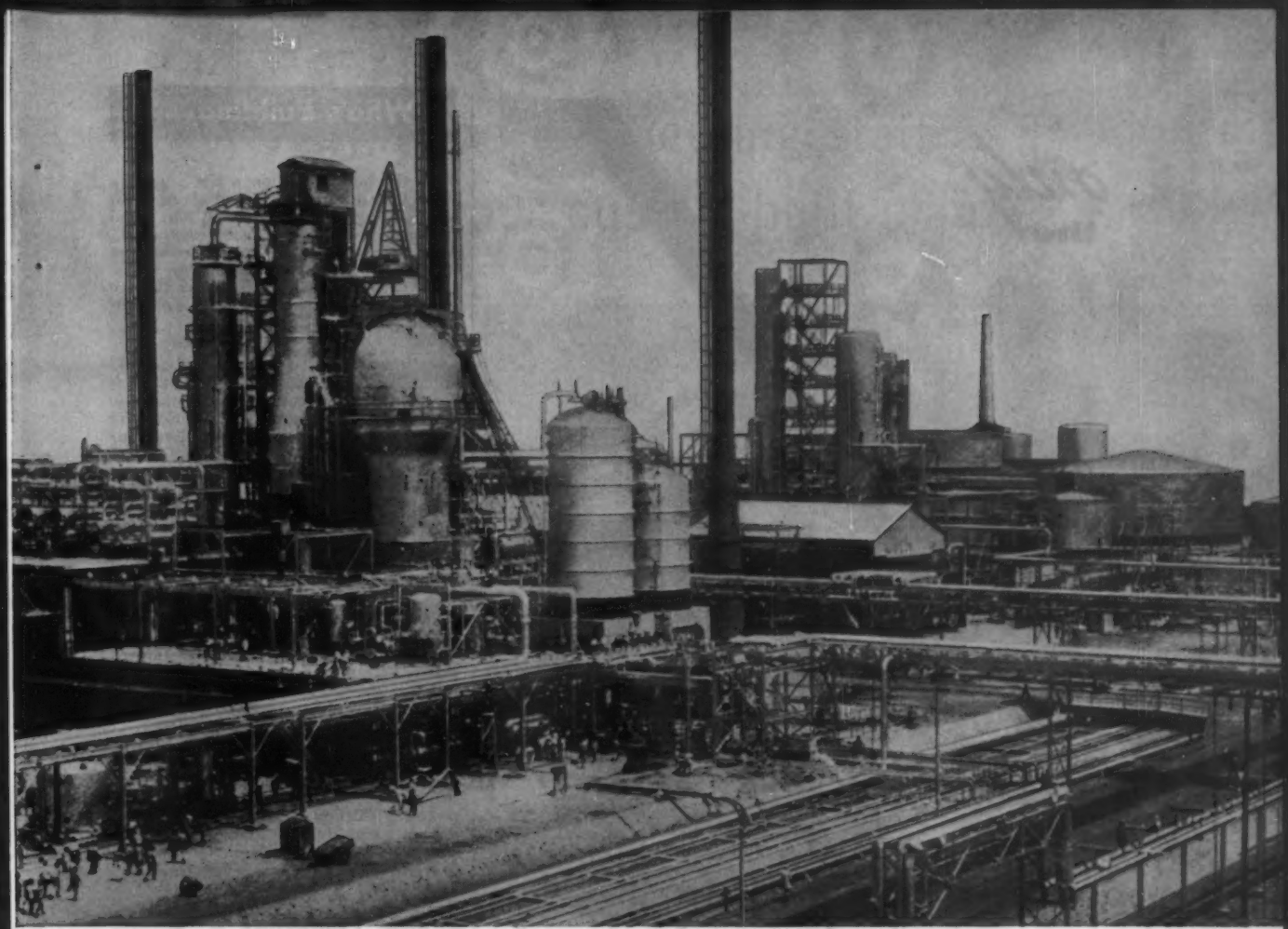
The Petroleum Chemicals, Inc., plant will be the first plant built since World War II. Its operation will increase national productive capacity for butyl rubber by about one-third, and Brown stated that it was hoped that full production might be achieved before January, 1959.

Foster Wheeler Corp. has contracted to



Representatives Inspect Model

Engineers from the Socony Mobil Oil Co. met with Pritchard designers recently to finalize piping and plant layout for a 9000 bpd catalytic reformer at Augusta, Kans. Shown examining the three dimensional model, built by J. F. Pritchard and Company, are the following Socony Mobil and Pritchard representatives (left to right) William Phillips, Pritchard; George Koutelas, Pritchard; Philip Ball, Socony; Fred W. Irwin, Pritchard; A. R. Garling, Socony; Karl Puidak, Pritchard; Joseph Gieck, Pritchard; E. E. Anderson, Pritchard; E. F. Moore, Socony; B. A. Burdette, Socony; Melvin Morrison, Socony; William Sweeney, Socony.



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When Burmah-Shell Refineries Ltd. entrusted to The Lummus Company the task of engineering and constructing India's largest oil refinery, a big factor in the decision was Lummus' unique experience — in design and construction, in bringing together men and materials in remote parts of the world, in coping with exigencies of climate and terrain. Burmah-Shell's confidence paid off. 21 months after work began — one year ahead of schedule — the Bombay refinery went on stream, today supplies half of India's petroleum needs.

When a handful of Lummus engineers and supervisors arrived on the site of the Bombay refinery, they found a stretch of water-bound rice paddies and scrubland, without roads, railway or harbor. Some of these specialists recruited and trained native labor — 14,000 in all. Others coordinated the flow of materials from overseas. Then came still other specialists to erect the intricate array of towers and piping that is a modern refinery. Obstacles of terrain were aggravated by Monsoon rains of unusual violence, but work never stopped until the 40,000 barrels per day installation was helping to fuel India's growing industries.

Lummus' half-century of worldwide experience counted heavily in the successful completion of this difficult project. But, even under more normal circumstances, the design and construction of a new plant does not lend itself readily to do-it-yourself solutions. It calls for the integrated abilities of a top-flight engineering and construction company.

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build the butyl plant on a site adjoining P. C. I.'s other petrochemical plants, built and building, at Lake Charles. The butyl rubber plant, like the other plants, will draw its raw material requirements from the hydrocarbon streams available at the Lake Charles refineries of Cities Service and Continental Oil Companies, joint owners of Petroleum Chemicals, Inc.

Continental Oil Co. will build a $1.75 million natural gasoline plant in the Short Junction oil field south of Oklahoma City. The plant will be constructed on Conoco's Nellie Fry lease in Cleveland County, four miles south of Oklahoma City's Will Rogers Municipal Airport and eight miles west of Moore.

Tuloma Builders, Inc., Tulsa, has been awarded the contract to build the plant, which will have a capacity of 60 million cubic feet daily. Preliminary construction work on the plant already has started, with completion expected by June 1.

Humble Oil & Refining Co.'s new benzene unit designed to produce approximately 24 million gallons per year of purified benzene is expected to be on-stream at its Baytown, Texas, refinery in December 1957.

Badger Manufacturing Co. has been awarded the contract which calls for the design, engineering, procurement and construction of the benzene unit, which will process 7000 bpd of aromatic containing stream, employing the Udex Process of Universal Oil Products Co.

Work on the project began November 2, last year.

Badger-Comprimo N. V., The Hague, Holland subsidiary of Badger Manufacturing Co. of Cambridge, Mass. and Comprimo, N. V. of Amsterdam, has been awarded a $6 million contract by Esso Standard Refinery S. A. to engineer, design, and construct a 5600 bpd powerformer, a 6900 bpd hydrofiner, and miscellaneous offsite facilities at Esso's Antwerp, Belgium, site. The unit is scheduled for early-1958 completion.

Fish Service de Mexico, S. A. has been awarded a contract for construction of a $3.5 million Frasch process sulphur plant for Central Minera, S. A. Central Minera, subsidiary of the Texas International Sulphur Co. owns a 123,000 acre sulphur concession on Southern Mexico's mineral-rich Isthmus of Tehuantepec.

Fish Service de Mexican subsidiary of Fish Service Corporation, Houston, is completing geological and engineering studies on the deposits located near the village of Texistepec, Vera Cruz, Mexico. Reports to date indicate that the sulphur deposits justify construction of the new facilities.

The proposed new facilities will have a capacity of approximately 1000 tons per day and will cost in excess of $3.5 million. Expected completion date is March 1, 1958.

Celanese Mexicana, S. A., affiliate of Celanese Corp. of America, has started construction of a new chemical plant near Mexico City for the manufacture of formaldehyde and the formulation of synthetic resins. The new plant, located 12 miles north of Mexico City, will supply Mexico's

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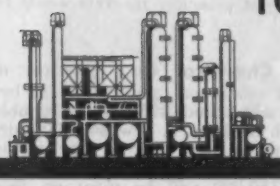

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Who's Building . . .

growing needs for components used in the manufacture of plastics and the finishing of various textile products. The planned production of formaldehyde marks the entry of Celanese Mexicana into the chemical producing field.

Additional facilities will be constructed at San Cristobal Ecatepec to house Celanese Mexicana manufacturing and storage operations now located in Mexico City. These include units for producing polyvinyl acetate emulsions and polyester resins, as well as a chemical storage tank farm.

Phillips Petroleum Co. has licensed Industrias Quimicas Electro Cloro, S. A., the Brazilian subsidiary of Solvay & Cie, to use its new low-pressure catalytic process for making rigid polyethylene.

Phillips also reports that it has started operation of the first unit of its 110 million-pound-a-year polyethylene plant near Houston.

Imperial Chemical Industries, Ltd., plans to increase the capacity of its terylene polyester fibre plant at Wilton, Yorkshire, England, from 22 million to 30 million pounds. Work on the project is to commence shortly with completion expected in early 1959.

Union Oil Co. of California, as part of its huge oil shale research and development program, expects to have an economical 450 to 500 bpd shale oil plant on paper within the next six months. The plant will have to be able to produce 25,000 to 30,000 bpd before a pipe line to West Coast principle markets would be economical.

Neville Chemical Co., producer of resins and other coal and petroleum by-products, will spend $750,000 to double its research facilities. A new $600,000 air-conditioned building will go up on the company's 50-acre Neville Island tract and another $150,000 will be spent on new laboratory and office equipment. The expansion also will mean a 50 percent increase in Neville Chemical's research staff.

Mellon-Stuart Co., Pittsburgh contracting engineering firm, already has started construction on the new 2-story brick building.

Badger Manufacturing Co., Cambridge, Mass., has started work on a naphthalene purifications plant for Barrett division of Allied Chemical & Dye Corp., the second such plant to be designed, engineered, and constructed for Barrett by Badger. This facility, expected to be on-stream late in 1957, will be located at Barrett's Frankford, Pa., site.

American Oil Co. has awarded a contract to Fluor Corp. Ltd., for construction of a gas treating and sulphur recovery facility at its new refinery in Yorktown, Va. This is the second addition announced by American Oil to the original plans for the $35 million refinery on the York River. Amoco previously had announced plans for construction of an asphalt manufacturing unit at Yorktown.

Of the units at the refinery, a crude distillation and catlytic cracking unit went into operation early in December after 16 months of construction. Limited operations are being conducted at a semi-continuous coking facility, and an ultraformer is expected to be ready in March. Construction of the new unit is scheduled to begin next July, and completed by November, 1957.

Shell Oil Co. will add a multimillion dollar alkylation unit to its Anacortes, Wash. refinery. The unit, which will be built by Fluor Corp., will go on stream around mid-1958, and will increase refinery capacity to 800,000 barrels annually.

National Cooperative Refinery Association has completed construction of its 1500 bpd refinery at McPherson, Kan. Construction, which was done by The Refinery Engineering Co. was completed in just a little more than six months after the ground was broken for the job.

Istanbul, Turkey will be the approximate site of a 65,000 bpd refinery which will be constructed jointly by four major oil companies. The major points of the plant have been agreed upon which sees the interest sharing divided 37 percent to Socony-Mobil Oil Co., 34 percent to Caltex Petroleum, 18 percent to Shell, and 11 percent to British Petroleum. Approximate cost of the plant will be around $48 million.

Standard Oil Co. (New Jersey) and the Norgewian government have reached an agreement in principle for con-

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H & B Castable No. 3	2700° F.	118-120 lbs.	127-129 lbs.	6750 PSI	50% of fireclay brick
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Super Castable No. 32	3000° F.	125 lbs.	131 lbs.	4660 PSI	65% of fireclay brick
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Lite-Wate Castable No. 50 NISF	2000° F.	48-50 lbs.	51-53 lbs.	800 PSI	16% of fireclay brick
Lite-Wate Castable No. 70	2300° F.	70-72 lbs.	80-82 lbs.	820 PSI	20% of fireclay brick
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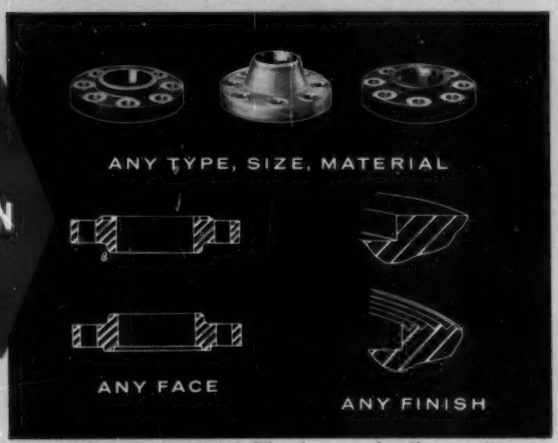

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struction of the long discussed refinery in Norway. Construction is scheduled to start in 1958 at a location that has been selected on the Oslo Fjord. Cost of the new refinery which will have a capacity of about 40,000 bpd, is expected to be around $29 million, of which 60 percent will be supplied in the form of dollar capital and loans.

When the refinery goes on-stream in 1960, production will be sufficient to meet all product requirements of Norske Esso, a small Jersey-Standard affiliate which owns the only refinery in Norway at the present time, and to export substantial quantities to Esso marketers in Sweden and Denmark.

The agreement between the Norwegian government and Jersey-Standard will be submitted to the Storting (legislature) for consideration and approval at its next meeting.

Shell Chemical Ltd., has officially put on stream, its new 30,000 ton per year alkyalte plant between Tilbury and Southend, England. Covering almost eight acres, the installation was constructed by Foster Wheeler, Ltd.

The plant consists essentially of four sections arranged on adjoining parallel plots: a tank farm, pump house, recreation section, and a distillation plant. Olefins and benzenes are vigorously mixed with a strongly acidic catalyst with temperature, reaction time, ratio of benzenes to olefins, and amount of catalyst being rigidly controlled. The catalyst is separated from the hydrocarbon mixture in a settler and is recycled to the reactor. Crude alkylate flows to a distillation section which consists of one atmospheric and two high vacuum columns, where detergent alkylate is separated from light and heavy impurities.

Matthew Hall & Co., Ltd., has been awarded the design and procurement contract as sub-contractor of Blaw-Knox Co., Pittsburgh, for the International Synthetic Rubber Co. plant to be built near Fawley, England. Total cost of this part of the plant is expected to be in the region of $11.5 million. Capacity of the plant will be about 50,000 tons per year, with production expected to begin late in 1958.

Brazilian Government has officially inaugurated its 5000 bpd Manaus refinery in the Amazon jungle. It is now running at capacity, yielding gasoline, kerosene, diesel oil, and fuel oil. Facilities to allow greater gasoline production are expected to be completed in the near future.

Initially, Venezuelan crude was run at Manaus. After November 1, crude from Ganzo Azul oil field in Peru began to be charged. When and if there is sufficient production from deposits indicated in the Brazilian Amazon region, it is likely that indigenous crude will replace Peruvian at the Manaus refinery.

Imperial Oil Co. Ltd., will add a Powerformer and a Hydrofiner to its Winnipeg refinery. The company also plans to boost its crude capacity from 15,000 to 17,500 bpd. Foster-Wheeler, Ltd., has been awarded the contract for construction of the new units which are scheduled for completion in early 1958.

Olin Mathieson Chemical Corp. is presently constructing a $1.5 million plant to produce automotive antifreeze at Mapleton, Ill.

Carbide and Carbon Chemicals Co. is building a multi-million dollar development laboratory in South Charleston, W. Va. Completion is scheduled for mid 1958.

Ashland Oil & Refining Co. plans to spend about $10 million in 1957 for additional improvements to refineries, and for the initiation of a program to manufacture petrochemicals. At the present time, Ashland has five refineries operating with a total crude capacity of 150,000 bpd.

The Standard Oil Company (Ohio) has awarded the largest single construction contract in company history by signing a contract for $34 million with The M. W. Kellogg Co. for the construction of a new refinery facility at the company refinery at Toledo, Ohio.

Who's Building. . .

Actual construction will start in early April on a tract of twenty acres within the present Toledo refinery grounds with completion expected by April, 1958. This will increase the presently rated 60,000 bpd capacity by 32,000 bpd.

The new project will combine in one area and in one integrated facility, atmospheric and vacuum crude oil distillation, delayed coking, catalytic cracking, hydrogenation, catalytic polymerization, catalytic

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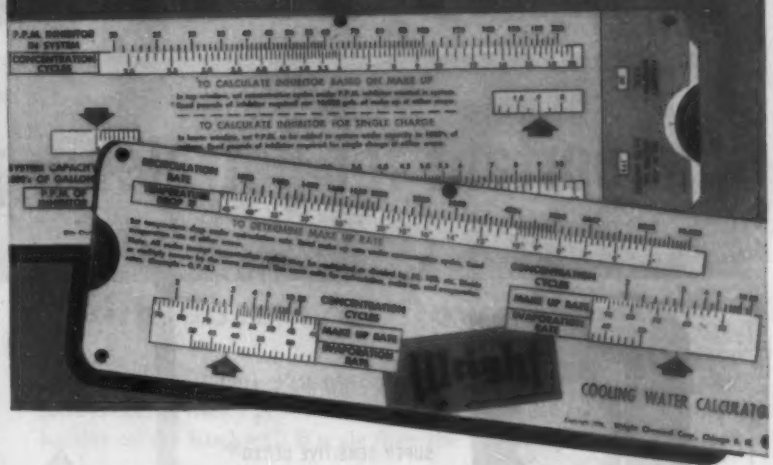

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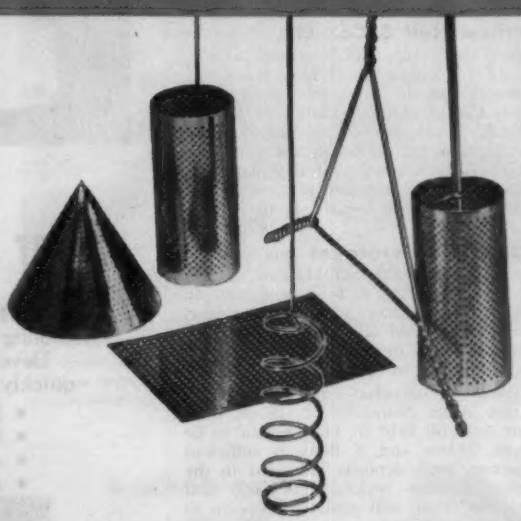

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reforming, gasoline recovery and stabilization, treating and continuous gasoline blending and steam generation.

The Kellogg contract is exclusive of the necessary off-site facilities which will probably run the cost of this new project to $40 million.

Shell Oil Company of Canada, Ltd., has placed a 6600 bpd Platforming unit engineered and built by Procon (Canada) Ltd., on stream at its Montreal refinery. The unit, which was designed by Universal Oil Products Co., is the second UOP Platformer started up by Shell in Canada. Last March a 3300 bpd unit, also erected by Procon, went on stream at Shell's Vancouver refinery.

The Fluor Corp., Ltd., Los Angeles, has been awarded a contract by Wyandotte Chemicals Corp. to design, engineer and construct a large-capacity electrolytic chlorine-caustic manufacturing plant at Wyandotte's new plant site near Baton Rouge.

This 1200 acre site on the Mississippi River, where an $8 million ethylene oxide plant is already under construction, has been named the Geismar Works.

The new electrolytic plant will cost over $20 million, and construction will begin in mid 1957 with completion scheduled for the last half of 1958. The Geismar facilities will increase, by nearly 60 percent, the caustic soda and chlorine capacity of Wyandotte.

Standard Oil Company (Indiana) will begin production of aviation jet fuel late next year or early in 1958 after new facilities are completed at its Mandan, N. D. refinery. Ultimately the refinery will be able to handle about one million barrels of jet fuel production a year.

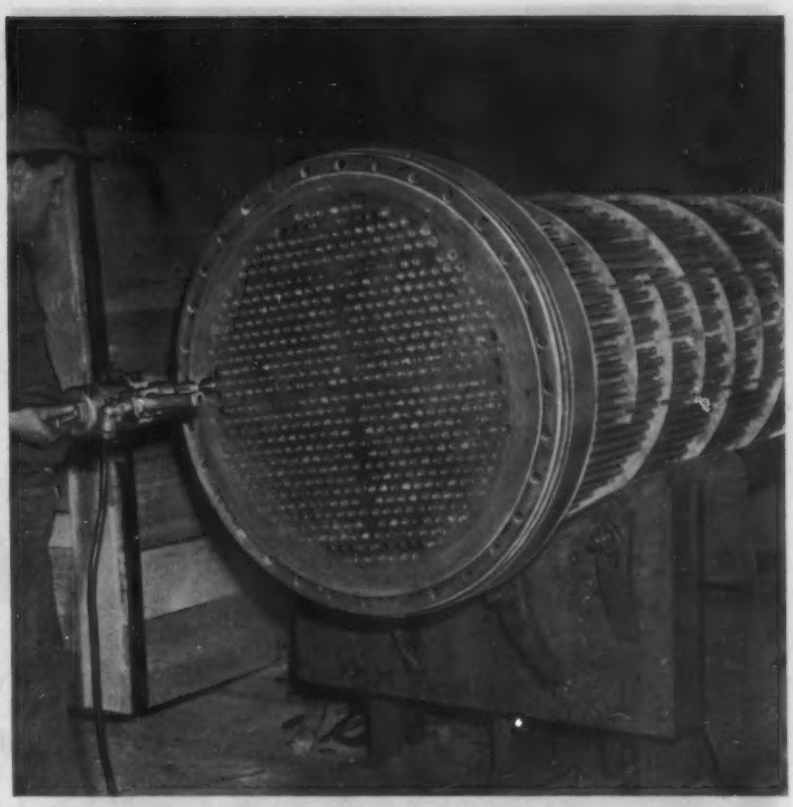
Plans which have just been approved call for the start of construction next summer on a new 96,700-barrel storage tank, pumping and pipeline facilities within the refinery, and a truck transport loading rack.

Celanese Corp. of America has started construction of a multi-million dollar acrylate ester plant at Pampa, Texas. With a capacity of 15 million pounds of acrylic acid esters a year, the plant is expected to begin production during the final quarter of 1957.

The Fluor Corporation, Ltd., has been awarded a contract by Socony Mobil Oil Co., Inc. for the process design, engineering and construction of a 3500 b/d sulfuric acid-alkylation unit and feed preparation facilities at Trenton, Mich.

Cost of the project will be approximately $3.5 million. Construction will begin next spring, with completion scheduled for the early part of 1958.

B. F. Goodrich Chemical Co.'s operations during 1956 were highlighted by an $11,000,000 expansion program. A major part of the expansion is taking place at the company's facilities at Avon Lake, Ohio, where vinyl resin production facilities are being doubled and development laboratories are being increased. This work is expected to be completed by March, 1957. Construction also started in October



Tricky assembly job handled with ease...at Downingtown

Specs said: Roll type 329 stainless tubes into type 316 and 304 tube sheets. A tricky problem, since the 329 tubes are 15-20 points harder on the Rockwell B scale than the 304 and 316 tube sheets.

What's more, an alert suggestion saved our customer the cost of a test shell, by utilizing the annulus created by the specified double tube sheet construction.

Design Pressure: Shell —125 psi at 300° F.
Tubes— 75 psi at 300° F.
Hydrostatic Test Pressure: 150 psi
Construction: Per ASME Code, Para. U-69...Customer Inspected
Tubes: 608 Stainless Steel Tubes, Type 329 (Carpenter #7MO)
¾" O.D. x 16 ga. x 15' 9" L.
Outer Tube Limit: 30⅝"...4 Pass
Floating Tube Sheets: Two—1½" and 2" thick...32⅜" O.D.
Fixed Tube Sheets: Two—1¼" and 1¾" thick...38⅜" O.D.
Shell Side Tube Sheets: Stainless Steel, Type 304.
Tube Side Tube Sheets: Stainless Steel, Type 316.

Write for helpful heat exchanger design data—Bulletin HE.

Downingtown Iron Works, Inc.
151 Wallace Ave., Downingtown, Pennsylvania
division of PRESSED STEEL TANK COMPANY Milwaukee
Branch offices in principal cities

DOWNINGTOWN IRON WORKS Hackney

HEAT EXCHANGERS—STEEL AND ALLOY PLATE FABRICATION
CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

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INSULATION on towers, tanks and exchangers must be kept DRY. If moisture gets through, the efficiency drops.

Modern refinery and plant design places many major insulated vessels "in the open." You can maintain the efficiency of your insulation with easy-to-apply Laykold Weathercoat.

Weathercoat is a fibrated asphalt-base material of easy troweling consistency that dries to a black, remarkably tough and tenacious coating. A majority of the leading refineries are regular users of Weathercoat.

A new product: Mastic Weathercoat, a bodied material, for use wherever economy demands the application of a *single,* thick layer.

Write today for our free illustrated brochure, entitled "Laykold Weathercoat for Insulation Protection."

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LEADING MARKETERS OF ASPHALTS, CUTBACKS AND BITUMULS—NATIONWIDE

Who's Building . . .

on a new plant to manufacture specialty acrylic polymers at Calvert City, Ky.

Associated chemical companies outside the United States also continued to grow. British Geon, Ltd. has started construction of a new Hycar rubber plant which will start operation in late summer of 1957. Geon do Brasil and Geon de Mexico completed installation of facilities doubling their original capacities.

In November, Japanese Geon commenced production at its new Geon plant at Takaoka which makes the current production rate for that company more than five times that of the original capacity started less than five years ago. Engineering by B. F. Goodrich Chemical Co. on the new plastics plant near Welland, Ontario, for B. F. Goodrich Canada, Ltd. is virtually complete and start-up is scheduled shortly.

Shell Oil Co. will build a new multi-million dollar Platforming unit to expand production of high octane gasoline at its Wilmington-Dominguez refinery in California.

Contract for the construction of the Shell Platformer, to begin early in 1957, has been let to Kaiser Engineers Division of the Henry J. Kaiser Co., Oakland, Calif.

The new refinery unit will increase the octane number of more than a half million gallons per day of gasoline components used for blending into premium gasoline fuel.

Cities Service Oil Co. has put into service the catalyst reactor of its new Rexformer at its Ponca City refinery. With the completion of the extraction unit, the entire unit will be the second to be placed into operation in the United States. The unit will have a 6000 bpd capacity. The crude unit which is another part of the multi-million dollar expansion and modernization program at Ponca City is scheduled to go on stream around April 1.

Royalite Oil Co., Ltd., and associates plan to spend up to $50 million within the next four years on development of the Athabasca oil sands 350 miles northeast of Edmonton. Royalite's initial plans call for the construction of a separation plant and a 20,000 bpd processing plant on the company's 50,000-acre lease at Mildred Lake. It is expected that construction will commence after the spring break-up this year. The separation and processing plants will be installed in 1958, while the heavy construction will be concentrated in 1959.

Tidewater Oil Co. has unveiled plans for further expansion of its 114,000 bpd refinery at Associated, Calif. The construction of two major units in the expansion, a platinum catalytic reformer and a steam generating plant is expected to be complete by March, 1958.

Other projects in the program include storage facilities for another 188,000 barrels; this includes one 131,000 barrel tank and a water treatment plant.

Initial capacity of the platinum reforming unit will be 25,000 bpd, with the capabilities of being expanded later to 45,000 bpd.

This will be the second major expansion at the refinery since early 1955. The first included the world's largest fluid coking plant, an 88 million cubic-feet-a-day gas

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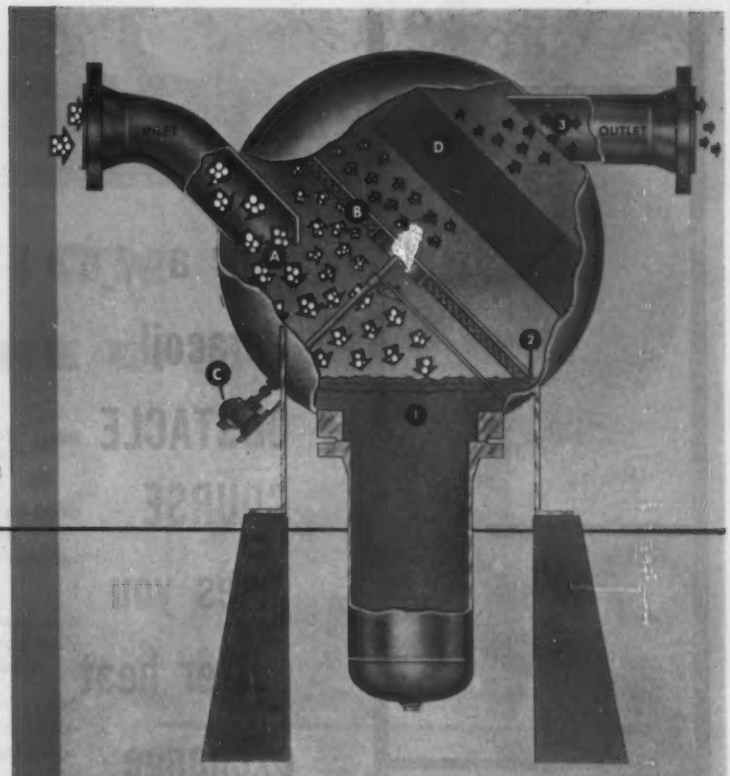
MORE EFFICIENT RESULTS!

PEERLESS SCRUBOSPHERE*

*Spherical scrubber for dust and liquid removal from gas flow

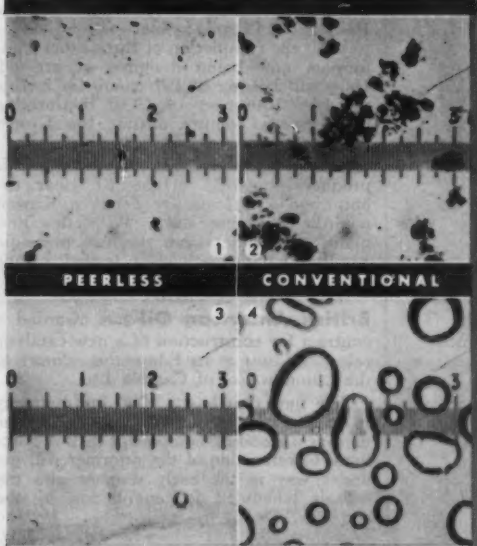


(A) The majority of incoming liquid and solid particles are directed down into reservoir. 1

(B) Lighter solid particles carried by gas stream are separated on surfaces of contactor which are kept wet and clean by revolving through liquid reservoir. 2

(C) Contactor is revolved by explosion-proof gear motor.

(D) Mist Extractor removes any remaining liquid particles from gas stream prior to outlet. 3



These photographs were made of microscope slides introduced downstream of the Scrubosphere and a conventional vertical oil bath cleaner under the same operating conditions. Plates 1 and 2 show the comparative amounts of iron oxide not removed with the amounts introduced being identical. Plates 3 and 4 indicate comparative oil loss with vapor rate through the vessels being the same.

LOOK AT THIS TEST The test at the left indicates the superiority of Peerless Scrubosphere over conventional oil bath dust scrubbers. The SCRUBOSPHERE operates with no loss of efficiency at low flows, minimum liquid loss, and very low pressure drop. Other outstanding features include easy vessel access with removable self-cleaning contactor, a sump for slugs of solid or liquid particles, and minimum cost.

For detailed information write for Bulletin No. 180

PEERLESS MANUFACTURING CO.

P.O. Box 13165 Dallas, Texas

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PEERLESS MFG. CO. DALLAS TEXAS

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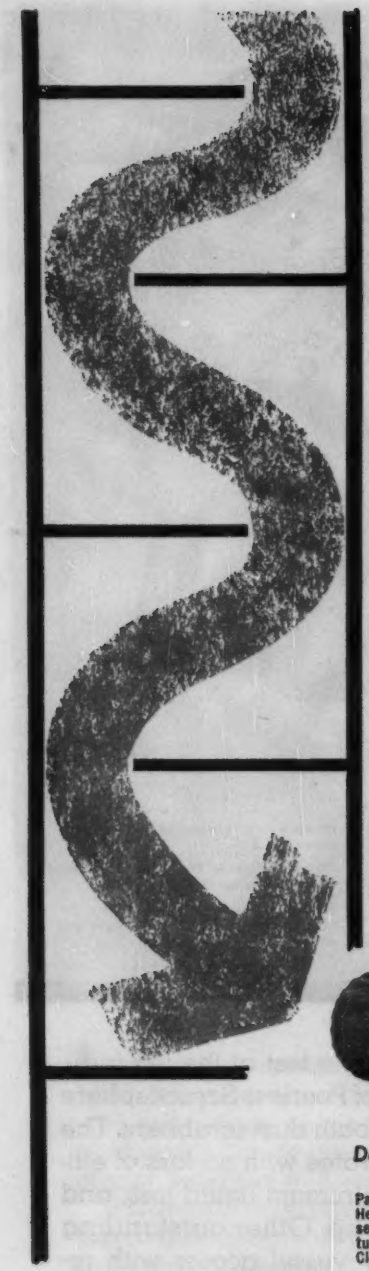
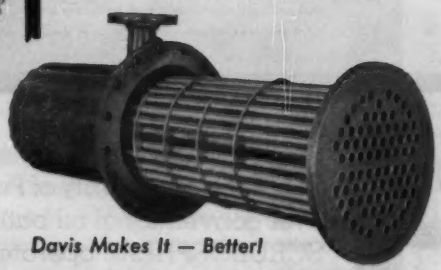


How a Paracoil OBSTACLE COURSE gives you better heat exchange



Davis Makes It — Better!

Paracoil Type "P" Exchanger, 2-Pass Type, Stationary Head End. Tube bundle partially withdrawn, showing segmental baffles. Note close tolerances between tubes and baffles, and between baffles and shell. Close baffle tolerances assure higher heat transfer rates.

Tumble the liquid . . . keep it baffled . . . make it take the long way home . . . that's what Davis will do to create proper turbulence to give you the most efficient heat transfer in equipment designed for your needs. And, we know just how to do it.

Our engineers have been designing equipment for chemical process industries, industrial process application, power plants, utilities and marine projects since 1915.

Write for Bulletin 1000

DAVIS ENGINEERING CORPORATION

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1064 East Grand Street, Elizabeth 4, New Jersey ELizabeth 2-6780

Who's Building . . .

plant, a 24,000 bpd hydrodesulphurizer, and an increase in catalytic cracking facilities.

Skelly Oil Co. has bought a natural gasoline plant from Kansas Power & Light Co. The plant which has a capacity of from 8000 to 10,000 gallons a day is located at Medicine Lodge, Kan. Skelly has plans for increasing the capacity to 40,000 gallons a day late this year by adding absorption and fractionation facilities. Natural gasoline and butane from the plant will be shipped by pipe line to Skelly's El Dorado, Kan., refinery for processing into finished motor fuel.

Allied Chemical & Dye Corp., Solvay division, will double the capacity of its plant at Brunswick, Ga. Approximate cost of the expansion which will take place this year is $10 million.

Quebec Ammonia Co., Ltd., will build a $9 million ammonia plant near Brockville, Ontario, Canada.

Chemical Construction Co. will build an ammonia plant for Asahi Chemical Industry Co., Ltd., at Noboeka, Miyazaki-ken on Kyushu Island, Japan. Capacity will be fifty metric tons per day utilizing the Texaco oil gasification process.

Asahi is Japan's largest manufacturer of synthetic fibers and explosives and one of the nation's leading chemical manufacturers. Ammonia from the new plant will be used by the company to manufacture rayon, ammonium fertilizers, plastics, explosives and other products.

Universal Oil Products Co.'s Platforming unit to be completed in Italy has gone on stream at the Industrie Chimiche Italiane del Petrolio refinery.

With the completion of three other Platformers now being designed or erected, Italy will be one of two countries having the largest number of UOP Platforming units in any country outside the United States.

The new 2,300 B/SD Platforming unit produces a 90/92 octane F1 clear debutanized Platformate from a Kuwait naphtha charging stock. With this new plant, the refinery can produce premium gasoline having a 98-100 leaded octane rating.

British American Oil has awarded a contract for construction of a new catalytic reforming unit at its Edmonton refinery to the Lummus Co. of Canada Ltd.

The new unit has a 4000 bpd capacity of high-octane reformed gasoline, to be used as a blending component in B-A gasolines. Construction of the reformer will get under way in the early summer and the unit is scheduled for completion by the end of 1957.

Standard Oil Company of California plans a record outlay in 1957 of more than $400 million for capital and exploratory purposes in the Western Hemisphere. Approximately $66 million will be expended in 1957 to expand capacity and further improve quality output of refining and chemical manufacturing facilities in

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ADSCO

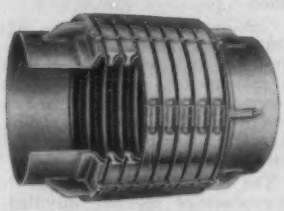
EXPANSION JOINTS ARE MORE EFFICIENT THAN EXPANSION BENDS...

and they cost less

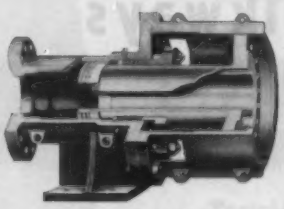
ADSCO Expansion Joints are more efficient than pipe bends for three important reasons:

1. **LESS HEAT LOSS.** A 12-inch line 1000 feet long, carrying steam at 200 lbs. and 550 F, will lose 16% more heat if bends are used instead of ADSCO Expansion Joints.
2. **LESS PRESSURE DROP.** The same line will have a 28% greater pressure drop with bends than with ADSCO Expansion Joints.
3. **LESS SPACE.** One pipe bend requires 100 to 300 sq. ft. of valuable space. An ADSCO Expansion Joint requires little or no extra space.

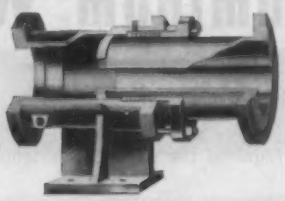
And, in addition, ADSCO Expansion Joints cost less. Used to absorb 4 inches of expansion per 150 feet of 12-inch pipe, an expansion bend, or loop, will cost 50% to 100% more than an ADSCO Expansion Joint. Similar savings can be obtained for other sizes of pipe and for different conditions.



Corruflex Packless Expansion Joint. Requires no maintenance.



Piston-Ring Expansion Joint. Can be unpacked at full operating pressure.



Internally Guided Expansion Joint. Traverses of 4", 8", and 12" per slip.

If you are planning construction of a pipe line, by all means investigate ADSCO Joints. If you already use bends, ADSCO can replace them with joints which will perform better and will still save money.

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ADSCO ENGINEERED PRODUCTS

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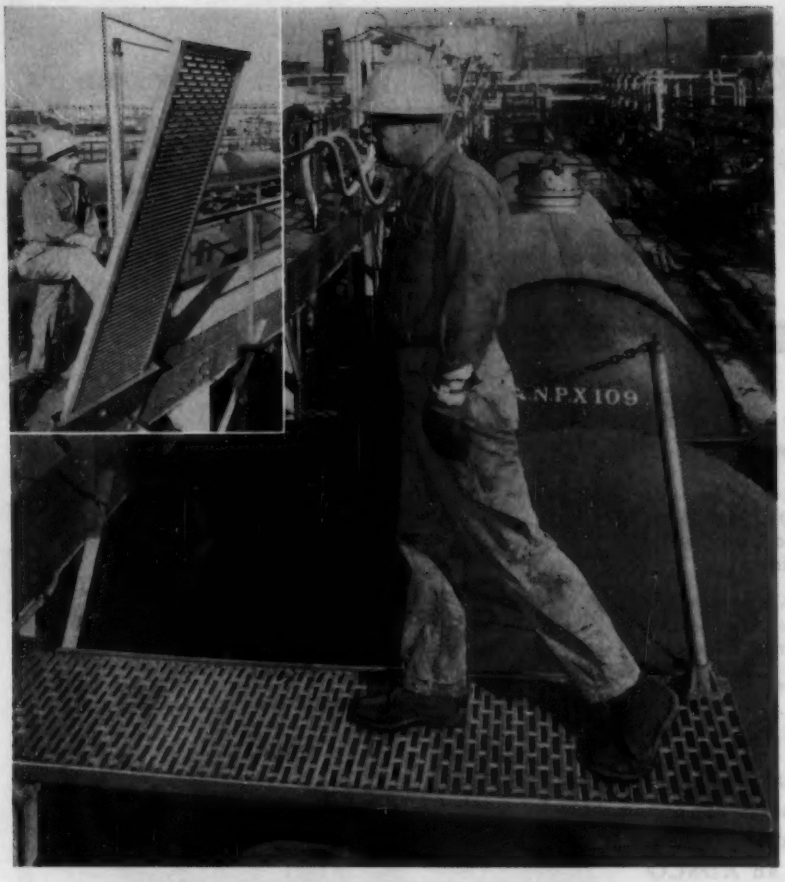

Esso Standard Oil's Baltimore Refinery Relies on

WACO Custom Fabricated Aluminum Walkways For Tank Duty!

For maximum safety and maintenance-free service, Esso Standard's refinery in Baltimore required the specially designed aluminum walkways illustrated above.

This is another "on-the-job" example of WACO's creative engineering and precision fabrication. WACO is America's largest company fabricating aluminum exclusively. Such specialization means finer methods of fabricating and welding, lower costs . . . more rapid delivery.

Specific advantages of WACO's non-corrosive, high-strength walkways include: an exclusive, patented surface pattern that reduces slipping in the presence of oil, water or grease. Walkway openings to facilitate air circulation, eliminate fume and odor pockets. Painting and other maintenance are not necessary.

When YOU Need Aluminum Walkways (or other products) Designed And Custom-Fabricated To Special Requirements, Specify WACO. For Illustrated Folder, prices and the representative in your area, write

WASHINGTON ALUMINUM CO., INC.

DEPT. 9-B, BALTIMORE 29, MARYLAND

PHONE: Arbutus 2700

Who's Building...

the United States. This is nearly double the 1956 figure for these purposes.

Shell Oil Co. will add a multi-million dollar alkylation unit to its Anacortes, Wash., refinery. The new unit will make possible the manufacture of about 800,000 barrels a year of 115/145 grade aviation gasoline to meet the growing needs of military and commercial aviation in the Pacific Northwest.

A contract for construction of the unit has been signed with Fluor Corp., with completion scheduled for mid-1958.

The unit will use a process in which olefins and isobutane are mixed and reacted in the presence of a catalyst (sulfuric acid) under refrigerated conditions to produce crude alkylate. The reaction product is then processed in fractionating columns to produce 2,400 barrels a day of crude alkylate for blending into aviation fuel.

Societe Anonyme Purfina has received government permission to build a 20,000 bpd refinery at Luanda, Portuguese West Africa.

Richfield Oil Corporation has purchased or obtained options on approximately 1000 acres of land on Puget Sound, 14 miles northwest of Everett, Wash., for a northwest refinery site.

Richfield's site, which includes Kayak Point on Port Susan, is accessible from two improved roads and fronts on water of sufficient depth to accommodate tank ships of any size. Crude oil will be received by tank ship or by pipe line connection with the Trans-Mountain Canadian pipe line which now extends to within 25 miles of the new refinery site.

Gulf Oil Corp., has announced that two new Gulfining units are being put into operation at the Port Arthur, Texas, refinery. These two units have a combined capacity of 45,000 bpd.

Gulfining is used to treat oils at 700-800 degrees fahrenheit in the presence of hydrogen and catalyst. By this process the sulphur content of the oil is greatly reduced and the oil is stabilized and otherwise upgraded, thus imparting a new degree of clean-burning, trouble-free characteristics to the fuel.

The hydrogen used to treat the oil is a by-product of recently installed catalytic reforming facilities. The sulphur is removed as hydrogen sulphide and recovered as elemental sulphur in another unit.

The two Gulfining units at Port Arthur were constructed by The M. W. Kellogg Co., New York.

Creole Petroleum Co. will build a Hydrofining plant at its Amuay Bay refinery in northwestern Venezuela to meet the demands for low sulphur heating and diesel oil.

Total estimated cost of this project is calculated at about $3 million. The approximate capacity of this unit will be 14,500 bpd of distilled oils obtained from the atmospheric and vacuum crude distillation plants of the refinery. The unit will consist of a reactor, a drum for the Hydroformer gas purification, a two-section furnace for the simultaneous heating of

For more data on advertised products, use Readers' Service Cards, last page.

THERMAL

Who's Building...

THE PROBE PROVIDES THE PROOF

proof that Kontol corrosion inhibitors effectively protect against hydrogen blistering in fractionating systems associated with catalytic cracking units. In case after case, the use of Kontol reduced hydrogen penetration, as indicated by probes, from a 20 to 25 psi build up per eight hour period to the 0 to 3 psi range. In addition, in every case, blistering was materially reduced or arrested. Metal losses were reduced in the 70% to 90% range and, due to Kontol's powerful detergent action, fouling and scaling on condensers, towers and exchangers became negligible.

Complete information and instructions for the fabrication of a hydrogen probe are available on request from the Tretolite Company.

Kontol is an effective corrosion preventive in virtually every major element of refining equipment. For complete information ask the Kontol service engineer in your area, or write to

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION
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Chemicals and Services for the Petroleum Industry

DEMULSIFYING, DESALTING, CORROSION PREVENTING, WATER DE-OILING, PARAFFIN REMOVAL, SCALE PREVENTING.

KR 56 II

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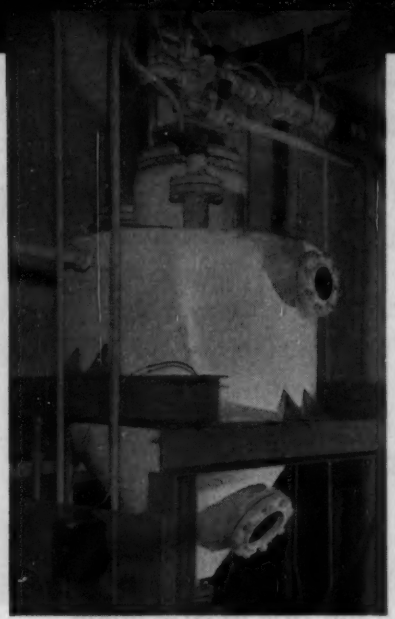
THERMAL
SUBMERGED
COMBUSTION



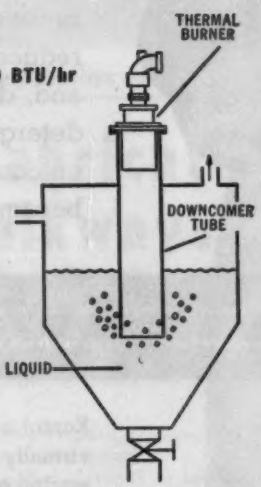
simplicity of

design and

construction...

***plus* extreme**

compactness



HEAT INPUTS OF 250,000 BTU/hr to 5,000,000 BTU/hr

The high heat release rate of the THERMAL High Velocity burner used in these submerged combustion installations allows the use of a simple downcomer tube through which the products of combustion are discharged beneath the surface of the liquid. This arrangement is possible because combustion is 90% completed within the burner proper. The THERMAL burner is completely separate from the liquid being heated and maintenance, control and accessibility are greatly simplified. Equally simple arrangements are possible with gas, oil or combination fuel.

BROAD RANGE OF APPLICATIONS

Depending upon the material being heated either a metal or refractory downcomer tube may be used. Some of the more common applications are pickling baths, acid concentration, caustic soda concentration, aluminum sulphate concentration, water recarbonization, and glass frit and molten salt heating.

WRITE FOR BULLETIN #110

OTHER THERMAL PRODUCTS & SERVICES → Gas, Oil & Combination Burners • Air Heaters • Combustion & Heat Transfer Equipment

THERMAL

Thermal Research & Engineering Corp.

CONSHOHOCKEN • PENNSYLVANIA

REPRESENTATIVES IN PRINCIPAL CITIES

Who's Building...

gas and oil, and other complementary facilities necessary for efficient operation.

Construction of the plant will be done under contract by Foster-Wheeler Corp., and will probably commence April, 1957, to be completed by February, 1958.

Phillips Petroleum Co. has licensed Industrias Quimicas Electro Cloro, S. A., Brazilian subsidiary of Solvay & Cie, to use in Brazil the new Phillips-developed catalytic process for making rigid polyethylene.

The agreement grants Industrias Quimicas Eletro Cloro exclusive use in Brazil of Phillips patents and technical knowledge for producing this new family of plastics.

The parent company, Solvay & Cie with headquarters in Brussels, Belgium, had previously been granted exclusive rights to use this process in Italy.

Phillips is now starting operation of the first unit of its 110 million pound a year plant to produce its new polyethylene at its Adams Terminal on the Houston Ship Channel.

Companhia de Petroleo da Amazonia has completed South America's first Fluid Catalytic Cracker designed by Universal Oil Products Co. at its refinery at Manaus, Brazil.

The 2000 bpd unit produces a 95 octane F-1 plus 3 cc TEL product from a synthetic blended crude stock and reached guaranteed output within two days of startup. This unit is part of a complete 5000 bpd refinery designed by Southwestern Engineering Co., Los Angeles. Southwestern also supervised construction of the plant.

Derby Refining Co. has completed its second major expansion within the past six years. In the $1.25 million program, the company installed the first Ultraformer in Kansas. Now, officials are studying the possibilities of producing synthetic chemicals with the unit.

Derby described the Ultraformer as making it possible for the plant to meet the highest requirements of 1957 and foreseeable future automotive designs. This apparently means that the company is prepared to produce 100 plus octane gasoline for its own service station outlets.

The expansion program also increased crude capacity by 25 percent from 16,000 to 20,000 bpd, and added to its asphalt capacity.

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PETROLEUM REFINER Subscribers

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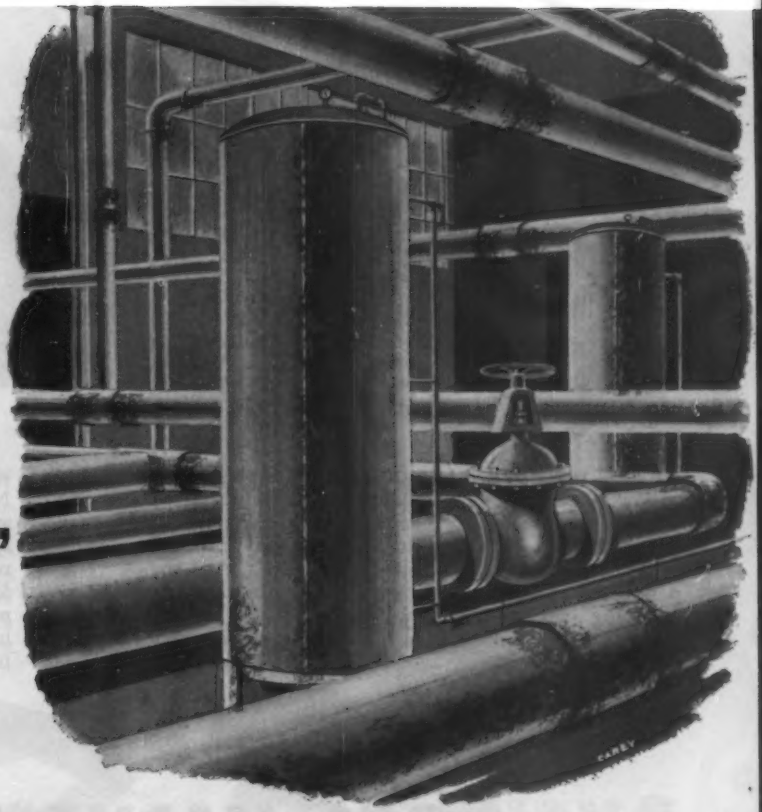
Protective coating failures usually begin with

"TROUBLE SPOTS"



Investigate the special properties of

Copon®

Severe corrosion problems solved with COPON include...

- Internal or external protection of pipes, tanks and vessels from solvents such as Aliphatic or Aromatic Hydrocarbons, Ketones, Esters and Alcohols.
- External protection of pipes, tanks and structures from heat, high humidity and chemical fumes.
- Protection of cooling tower headers, air washers and heat exchangers.
- Protection of production equipment from the severe corrosive action of cutting coolants.

COPON coatings provide superior protection for seams, welds, sharp edges and other corrosion "trouble spots." They provide higher film build-up per coat and cling tenaciously to metals and alloys. They last longer, because Copon remains tough and elastic even when subjected to chemical fumes, heat and high humidity. And they are less likely to be mechanically damaged, because Copon offers greater abrasion resistance than most protective coatings.

Easily applied by brushing or spraying, there is a selection of Copon coatings designed to solve or prevent severe corrosion problems. They have been used successfully to protect offshore drilling rigs, internally coat new and used pipelines, stop corrosion losses in chemical plants and paper mills, and in many other installations where corrosion costs were skyrocketing.

For complete information on Copon, write on your company letterhead to the manufacturer located nearest your city.

Copon®

FOR CORROSION CONTROL

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Birmingham 5, Ala.

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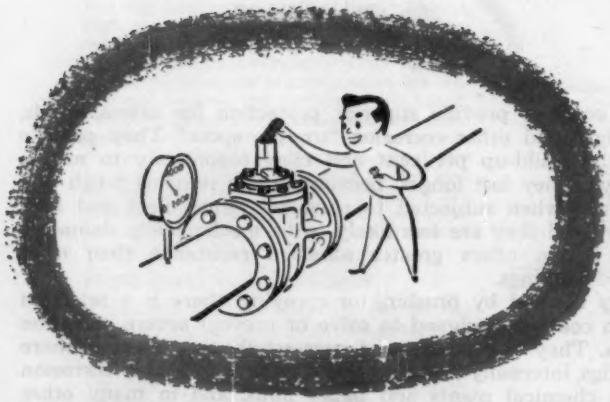
2929 Main St., Buffalo 14, New York

JAMES B. SIPE and COMPANY, INC.
P. O. Box 8010, Pittsburgh 16, Pa.

WHAT IS THE ADVANTAGE OF A LUBRICATED VALVE?—The most important advantage of a lubricated valve is that it *seals far tighter* than ordinary valves. The thin film of plastic lubricant forced into the ports of the plug is a pressure seal in itself. And the possibility of seizing or galling is eliminated because the plug can be hydraulically jacked for instant operation. Lubrication is also *preventive maintenance* against down time.

WHAT DOES THE LUBRICANT DO?—In a Rockwell-Nordstrom valve, lubricant is forced through grooves surrounding the plug ports where it acts as a *double seal* against leakage. By hydraulic action, lubricant under pressure also jacks up the plug keeping it free for *instant quarter-turn* operation. And lubrication means that operation is smooth and easy. Finally, lubricant prevents grinding wear for longer valve life at lowest cost.

DOES VALVE LUBRICATION ???



WHAT LUBRICANTS SHOULD BE USED?—Insist on genuine Rockwell lubricants—Rockwell is the largest and most experienced manufacturer of valve lubricants in the world. Rockwell lubricants are the result of years of field experience with nearly every process condition. For many services, there are variations of Rockwell lubricants compounded to offset specific line conditions. See your Rockwell sales engineer or write for Bulletin V-220 for complete details.

HOW LONG WILL PROPERLY LUBRICATED ROCKWELL-NORDSTROM VALVES LAST?—Many of the first Nordstrom valves put in service are still going strong. In gas distribution installations there are many valves with more than 30 years service. In a two-year paint plant study, Rockwell-Nordstrom valves were the only ones that did not need to be replaced because of leakage. Lubricant assures extra years of perfect service you can't expect from "dry" valves.

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ROCKWELL-

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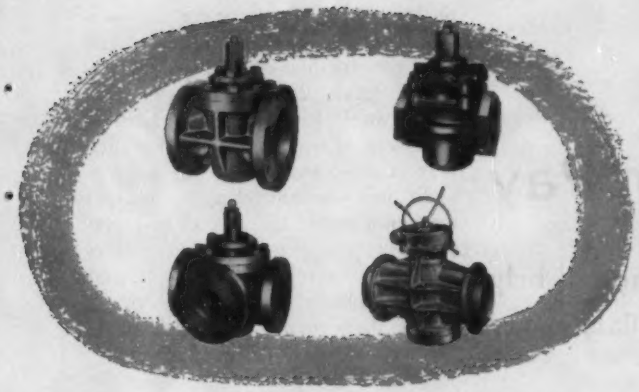
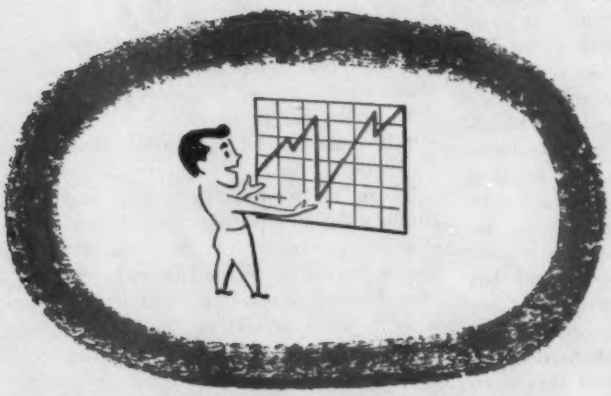


WILL A ROCKWELL-NORDSTROM VALVE WORK WITHOUT LUBRICANT?—Yes, (even your automobile will function a short while without lubrication) but then the whole advantage of a lubricated valve is lost. Rockwell-Nordstrom lubricated plug valves are made to exceptional standards of tolerance and quality. However, it is their internal lubrication system which raises performance and economy standards far above any other type of valve.

HOW OFTEN SHOULD NORDSTROM VALVES BE LUBRICATED?—Basically, lubrication depends on service-temperature, process, frequency of operation, etc. Genuine Rockwell lubricants actually keep periodic lubrication to a minimum because they are specially compounded to handle specific services. Rockwell lubricant fittings of a button head type make the job fast, easy and every Rockwell-Nordstrom valve can be lubricated in service.

COST MONEY OR SAVE MONEY?



WHAT ABOUT MAINTENANCE COSTS?—Basically, lubrication is preventive maintenance against wear, replacement and down time costs. Also, lubrication—the key to leakproof, positive shut-off in Rockwell-Nordstrom valves—is an investment in safety and product loss or contamination. It's almost a mechanical axiom that *any* fully lubricated mechanism will require far less repair and parts replacement than a non-lubricated one.

YES, FOR 40 YEARS IT HAS BEEN PROVEN IN EVERY INDUSTRY THAT ROCKWELL–NORDSTROM LUBRICATED PLUG VALVES SAVE MAINTENANCE, REPAIR AND DOWN TIME DOLLARS. LUBRICATION IS AN INVESTMENT IN BETTER SERVICE, LONGER LIFE AND LOWER COST.*

**Note: First cost of Rockwell-Nordstrom valves is about the same—often lower—than ordinary valves.*

Rockwell-Nordstrom valves are available in semi-steel, steel, stainless and corrosion resisting metals and in a *full range* of sizes and pressures. For complete details on Rockwell-Nordstrom valves or Rockwell lubricants, see your supplier or write: Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited.

Nordstrom VALVES

FOR POSITIVE SHUT-OFF

Make Your Bonus Plan Pay

Here is a year-end bonus plan that will help you increase employe loyalty and save tax dollars at the same time.

Jack E. Bedford
Professor of Management
Armstrong College, Berkeley, Calif.

THE FAST GROWING number of refiners who use a year-end bonus plan as part of their compensation program for key personnel find it has many advantages—and very few drawbacks.

The advantages:
- Increases employe loyalty.
- Saves tax dollars.
- Reduces absenteeism.

The Drawbacks:
- Costs money.
- Takes time to compute.

And here are the reasons why the advantages far outweigh the drawbacks.

Increases Executive Loyalty—Refinery executives who are compensated in part by a bonus plan develop a more loyal spirit. They have a stronger feeling of belonging to the profit team of your organization. The year-end bonus makes these people feel they were in part responsible for the profits of the refinery. They will put forth extra effort to keep profits up and the bonus payments coming in each year in the future.

In addition to this type of loyalty, a year-end bonus plan will improve your refinery's prestige in the area and in the industry. You will have plenty of applicants for any key spots that to develop in your refinery. People like to work for a firm that divides its profits with its employes.

Reduces Income Taxes—Refinery management realizes income tax savings when it has a year-end bonus plan. Naturally, your income tax payments are not reduced by the amount of your bonus payments. But, *your taxable income is reduced dollar-for-dollar by the amount of your year-end bonus payments.*

Based on the corporate income tax rate, your bonus payments cost you (out-of-pocket expense) 48 cents for every dollar of bonus you pay to your key men . . . an inexpensive way to improve morale and strengthen loyalty of your executive team.

Base Bonus on Merit—Santa Claus is fine on Christmas, but most people do not expect him every day of the year. And, if you pay your year-end bonus as a gift, it will not accomplish as much as possible in building loyalty and increasing production or reducing costs. Then, too, a gift is not a tax deduction like a bonus based on merit is according to the Internal Revenue Bureau.

As a general rule, you will find that a year-end bonus is appreciated more if it is awarded on the basis of merit. Your employes will work harder and be more loyal if they feel they earn the year-end bonus you give them.

Some refineries base the year-end bonus payments on the basis of results. This method has much to recommend it from an executive development standpoint and taxwise. However, the practical limitations of establishing exact figures for various people on the executive level is obvious. There is no yardstick to measure results of a top management team on an individual basis.

Another plan is to base the bonus on the length of service for the individual involved. For instance, if the total time of five executive level employes totals 25 years service, the bonus would be paid on the basis of 4 percent of the total bonus for each year of employment. If total employment time was 200 years, the share of the bonus would be one-half of 1 percent per year per man. This system has much to recommend it. It puts extra emphasis on executive loyalty and tends to reduce labor turnover in the key spots of your organization.

Still another plan of allocating the year-end bonus to the management team is to base it on the annual income of all people involved. The total payroll of the group is divided into each man's annual earnings. This provides a percentage figure to be used in dividing the year-end bonus for each member of your management team.

Other factors may be worked into the allocation of the year-end bonus plan. For instance, you may want to include a provision for encouraging new executives. You may want to give extra bonus payments for outstanding accomplishments of certain individuals. Or, you may want to reward your loyal men with extra payments. All of these, and other profit factors, can be worked into a petroleum refinery's year-end bonus plan.

Avoid Tax Pitfalls—Taxwise there are two things to keep in mind about your year-end bonus plan:
- It must be "reasonable."
- It must not be a disguised dividend.

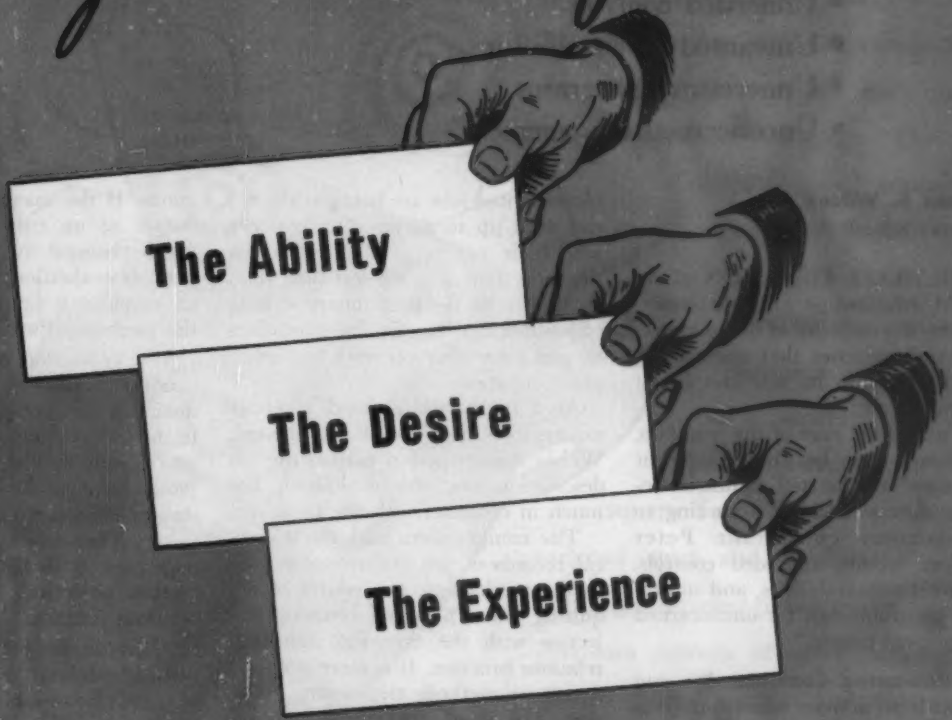
There is no exact mathematical formula for computing the "reasonable" requirement of the year-end bonus. According to the Internal Revenue Bureau, a bonus is "reasonable" if it is what would be paid under similar circumstances by similar firms for similar services.

As a general rule, the Internal Revenue Bureau interprets "reasonableness" by the skill or training required to perform the job, the amount of responsibility demanded on the job, the profit earned as a result of the work, and the future prospects of the individual and the management of the refinery.

Requirements for year-end bonus plans also cover the "disguised dividend" aspect. This provision hits

Continued on Page 224

When You check these factors . . .



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The Plight of Industrial Relations

In some companies, line management and employes show uncertainty, even hostility toward industrial relations departments. There are four good reasons why:

- **Unneeded controls.**
- **Unwanted responsibilities.**
- **Unnecessary programs.**
- **Unconcerned management.**

William S. Wilcox
Newtown Square, Pa.

THE STAFF FUNCTION of industrial relations is so little understood by the majority of line management and employes that uncertainty, even hostility, to its activities is not an unusual attitude.

To get to the core of the situation, attention has to be given to "Four Horsemen" of the staff industrial relations dilemma which, according to management consultant Peter Drucker, "create unneeded controls, unwanted responsibilities, and unnecessary programs—all for unconcerned management people."

1. Unwanted Controls—We can start with an activity which unnecessarily creats unneeded controls, a project much debated and hotly contested with industrial relations staff people by both unions and line management—job evaluation and wage and salary administration.

In a job evaluation undertaking, there are a number of choices of methods ranging from as simple a one as stacking a pack of cards to one so complicated as to light a glow in the eye of a research statistician. Naturally the cost in installation and administration expense is relative to the claimed precision of the method chosen.

In one highly considered precise method—a committee of high level executives sat through endless hours evaluating all jobs, however minor. This method is acclaimed for its internal and external consistency.

An objective audit of salary time and other costs of the executives, the industrial relations staff and the employes whose jobs are being evaluated can total up to an amazing cost per job. It is not surprising in such a situation that in much less time than it takes to do the preliminary writing of job descriptions, the line executives tapped for evaluation work find other pre-occupations.

As a result, the claimed *precision* expires soon after the job is evaluated. Within a short period neither the job description nor the evaluation has much in common with the facts.

The computations and the statistical records of job evaluation as well as the mechanistic procedures of acquiring them have no common objective with the historical industrial relations function. It is more properly a cost or methods engineering function. The involvement places an industrial relations staff at cross purposes to its human relations objectives.

There comes a time when facts, no matter how carefully collected and accurately tabulated, must be subjected to assessment and judged as to their significance in individual situations. If the maximum value of the output of an employe's job can be pre-determined by pure stastistics as per job evaluation, then the work of an employe is on the same level as the mechanical work of a machine.

The imposition of a mathematical maximum pay to individuals is a denial of the inherent ability of intelligent and alert employes to grow and yet remain within the scope of the job and to produce results beyond any statistically pre-determined maximum value. The defense of a statistical maximum is foreign to the accepted human objectives of the industrial relations function.

Many of the job evaluation practices throughout industry would be changed measurably and materially, if the industrial relations staffs were not operating in this false position and thereby having the need to defend the work. Compounding the "mischievous error" is the misdirection of the subsequent administration, which as an accomplishment, was proudly referred to by a wage and salary administrator in a recent issue of an authoritative journal on personnel management as "stabilizing wage and salary rates at average levels." That presents a changed objective from paying an employe for what and how well he individually does the job.

Also, the imposition on line managements of these maximum job rates results in a leveling that is completely foreign to American industries' concept of individual enterprise and personal incentives. It is a socializing process. It is an "unneeded control" that denies both the objective and the intent of line management to pay

To be effective, an industrial relations department must implement four important functions:

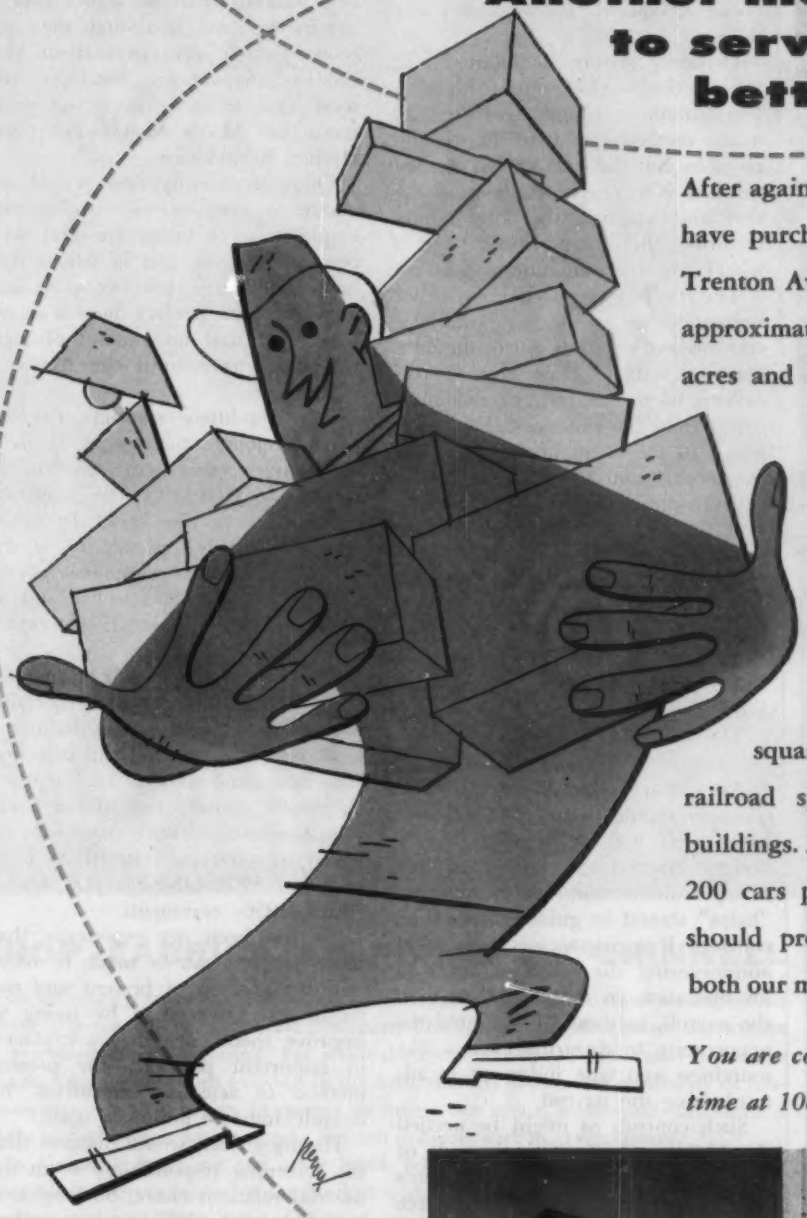
1. Bring to management's attention situations which might cause trouble—before the trouble starts.

2. Suggest courses of action to prevent or correct trouble.

3. Follow practices to correct faulty application.

4. Suggest changes in policies and practices to meet changing conditions.

Another move, to serve YOU better . . .



After again outgrowing our quarters, we have purchased property at 108 North Trenton Avenue, in Tulsa, consisting of approximately three and one quarter acres and several buildings. The main office building contains in excess of 14,000 square feet. Our rapidly expanding engineering department will be housed in a separate two story building with about 37,000 square feet. We have our own railroad spur and equipment storage buildings. A paved parking area for about 200 cars permits offstreet parking and should prove a great convenience for both our many visitors and our employees.

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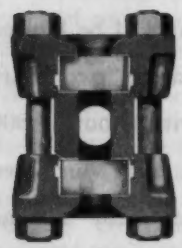

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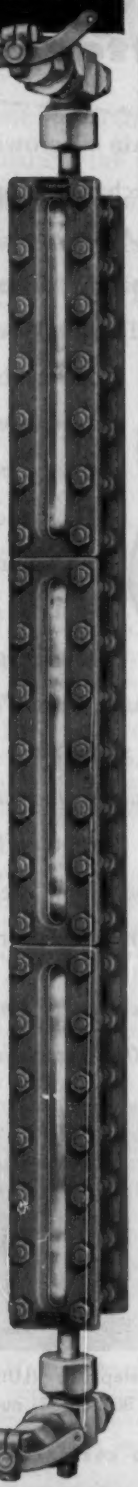

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people adequately for what they produce.

Certainly anyone acquainted with the practical working out of this problem can cite by chapter and verse the many methods used to hurdle the obstacle. Not the least known of these methods is to rewrite the job description and upgrade the job, thereby throwing "the line of best fit" out of whack and the evaluation into a tizzy.

The measure of effectiveness of job evaluation is not in the unneeded controls and certainly not in the inexhaustive statistics, nor even in the fullness of the number of executives involved in the processes. The measure is in the effect of the results on the morale and the will to produce of individual employes.

If the final objective of a plan is to aid the responsible management of an organization to administer pay and salaries wisely and soundly, then there are only two pay levels to consider—and neither of them need be controls.

The first level is the entrance or learning pay for each job.

The second level is the pay to be attained after the learning period.

After that period, a responsible manager should be free to administer his payroll within the total payroll budget granted to him. Wage and salary administration pay limits and "helps" should be guides rather than controls. If a manager is capable of administering the financial assets of his operation in matters other than the payroll, he should be granted the opportunity to demonstrate a like soundness and wise judgment in administering the payroll.

Such controls as might be needed should be arrived at as a result of annual post-audits of the manager's payroll performance. To the degree that a responsible manager is restrained by statistically arrived at pay limits from acting promptly and fairly in granting earned pay increases, his facility for improving, let alone maintaining the productivity of employes, is weakened.

2. Unnecessary Programs—The enchantment of enlightened absurdity has at all times operated to varying degrees in staff activities—industrial relations no less than others—and in certain instances so effectively as to deny logic and confuse analysis. At present the currently popular executive development programs (supervisory training with its sights raised) are in the spotlight though there are omens which seem to indicate that the executives being developed will soon have to move over and make room for Mass Motivation and Human Behaviorism.

Quite apparently new people are about to discover old truths—that employes work better for and with people they like and in whom they have confidence. However, as an academic research project there is an enthrallment that no amount of logic will overcome until the frenzy is worked off.

How absolutely essential an executive development program is in a company depends greatly on how effective or ineffective the industrial relations work has been. It would appear from the popularity of the programs that the executives of industry were poorly selected and ill prepared to carry out their responsibilities.

To change the methods of an executive in office is not a comfortable responsibility. The present industrial relations' mass effort in this direction may have some influence on line management's attitude toward the function. One authoritative voice is being raised in question. Edward N. Hay, editor of PERSONNEL JOURNAL (June, 1956) comments:

"It has been my experience that more progress can be made by more effective analysis of present and potential executives than by trying to improve them once they are placed in important positions—the present method of selecting executives 'by default' must be improved upon."

Hardly anyone would disagree that the screening responsibility is an industrial relations chore. So long as a staff industrial relations executive has no authority to veto a wrong selection or even to submit candidates for executive vacancies, formal executive development programs will bloom as a sort of after-the-act complicity.

It cannot be ignored that today's management people somehow struggled to their abilities mainly through self-development. Where that urge is lacking in the individual, it is an open question as to how much improvement can come from forced feeding off the job.

On the other hand, since 60 per-

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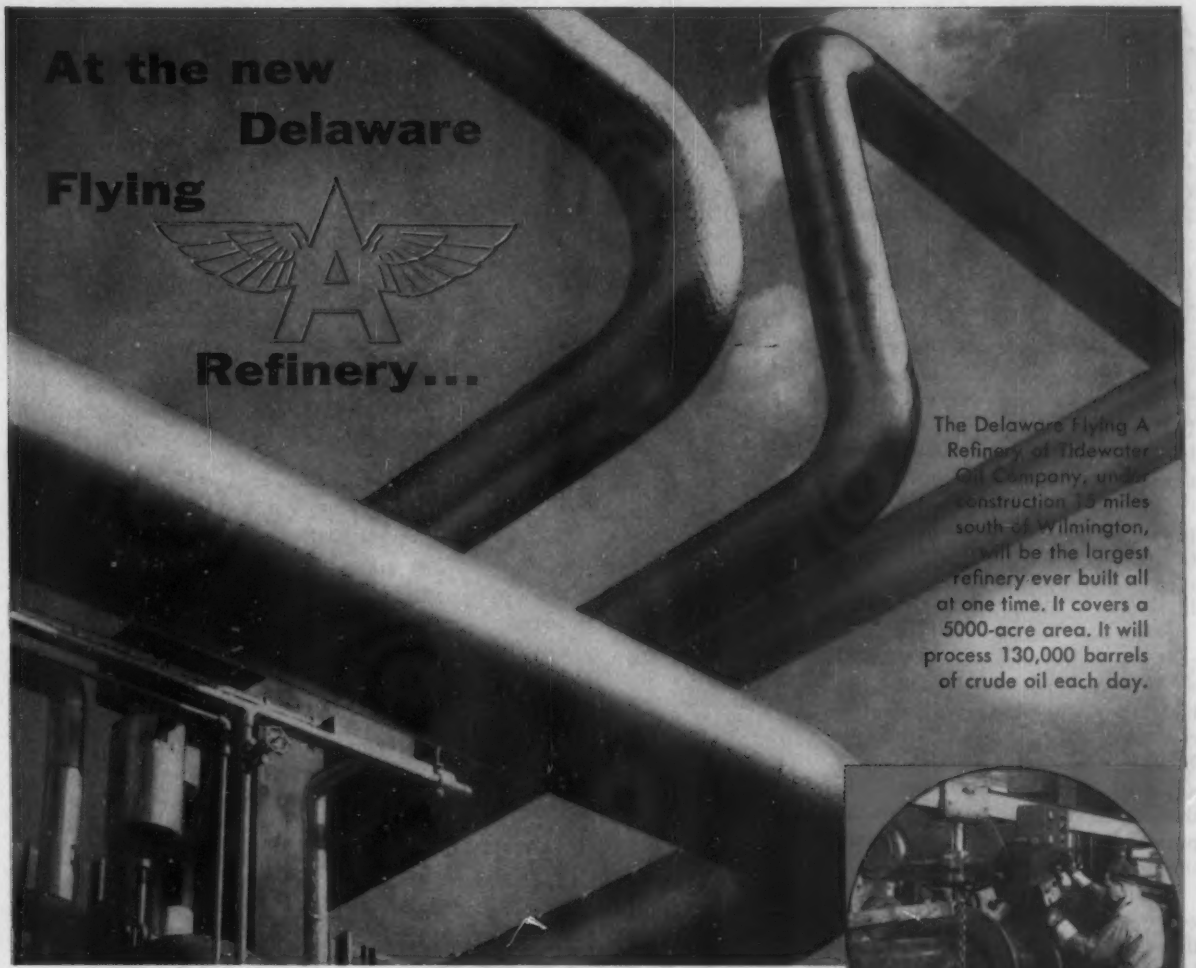

The Delaware Flying A Refinery of Tidewater Oil Company, under construction 15 miles south of Wilmington, will be the largest refinery ever built all at one time. It covers a 5000-acre area. It will process 130,000 barrels of crude oil each day.

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Welding under ideal conditions in Grinnell shop. (Top) Automatic, submerged-arc welding machine. (Bottom) One of many Grinnell welders who must meet full operator qualifications of the ASME and ASA codes.

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cent of the present executive development programs have been in effect less than five years, it is yet to be determined how many of them are a response to an actual internal problem of inadequate executive selection and preparation, and how many represent a move to "keep up with the Joneses."

3. Unconcerned Management—The third Horseman has to do with "unconcerned management people." Newspapers and business magazines have been pointing to the declining number of annual additions to the country's labor force. Even more impressive are the growing columns of help wanted ads, with their enticements to "join our happy family of highly paid people."

Every staff industrial relations department—and this applies peculiarly to those with research sections—have had access to the population and economic statistics published by the U. S. Government. Experts pinpoint a total labor force increment of less than a million employables annually projected through 1960—far under the need.

Many personnel directors have had access to these statistics. However, if they acted upon the knowledge and failed to get attention by "unconcerned management," the staff status of individual relations can be blamed.

Without authority to take any effective steps other than to advise the line managements, staff industrial relations could only stand by for action that took place too little and too late —if at all. In other instances where staff industrial relations departments did not bother themselves with economic and labor force statistics (one industrial relations research director commented, "One thing we will not be is a statistical department") the staffs are as shot full of vacancies as the line operations they aim to please.

With the labor shortage here and likely to continue for at least a decade, what can a staff industrial relations department do about it? Under the clear visibility of the unfilled vacancies, they can induce line management to take a searching look at tomorrow's needs as well as today's shortages. Tomorrow being the next five years. This is a staff industrial relations project that every member of management can understand—and may agree with.

Another opportunity is offered within the community around a company. In the face of the present manpower shortage, now is an appropriate time to review the employment practices which are failing to fill the vacancies. A choice between throttling the progress of a company and the employment of available overage, annuitant, minorities and physically handicapped should not be difficult.

An industrial relations department has an overriding responsibility to assure the continuity of a company's existence by insuring a continuity of its labor force. A failure to do this is a failure in functional performance. A staff industrial relations department with the courage to face the issue and armed with the facts is performing its function when it speaks frankly and forthrightly.

It is not simply a matter of bringing people into a company to fill yesterday's vacancies, it is a compulsion to bring in the type of people—with stamina and vision—who will solve tomorrow's needs before they occur. This is not an "unconcern" of management it is a misconception of the importance to a company of the man through whose eyes and mind pass the candidates who in time must supply the management brains and the productive energy.

There was a panicky sort of grasping at a straw in a recent 20-square-inch display WANTED in a metropolitan newspaper:

Technical Personnel Recruiter

Man with scientific background—personnel experience not necessary. This man will interview professional people, handle college recruitments and company placements . . .

One wonders what kind of a company will eventually develop from the placement by a stranger of strange people into a strange organization.

It is quite evident that in the near future as the economic and manpower war gets hotter, entire industries and their member companies will have to pre-select and prepare their own candidates for professional and skilled jobs rather than continue the often fruitless and always disorderly bidding for a dwindling available supply. This is a priority staff industrial relations program of primary importance, dwarfing in its potential effect on a company, any and all of the currently popular activities.

A harbinger of coming events took place this year in the food industry. A group of local and national concerns jointly sponsored an essay-type contest for young men who might be induced into food marketing at two outstanding universities. The response was so excellent that several other trade groups are considering similar efforts on a national scale. This can be said for the effort: The selected candidates were eager and ambitious.

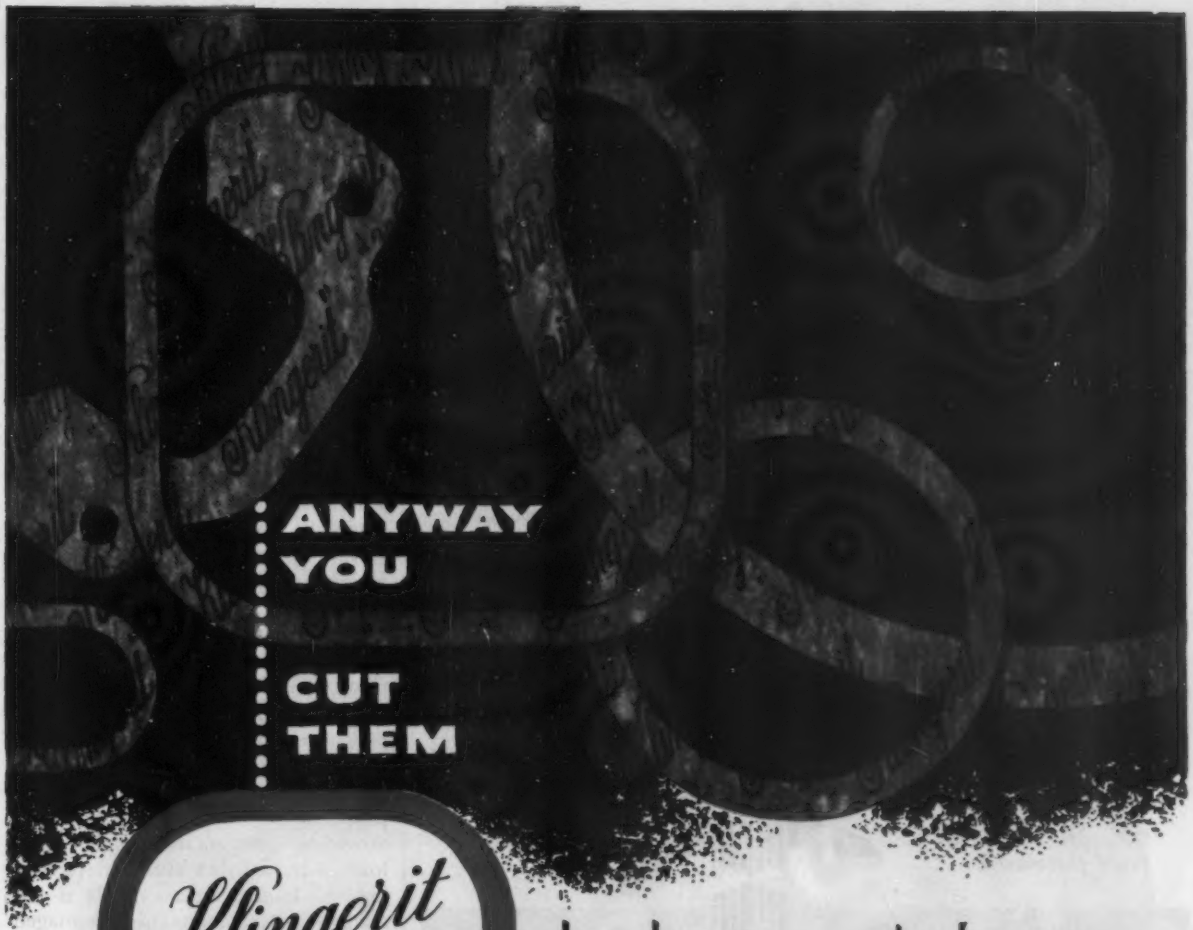
4. Decentralizing Unwanted Responsibilities—In recent years, innumerable industrial relations activities have been added to the foreman's duty sheet—with the concurrence if not the connivance of staff industrial relations people. A quick review of these added duties disclosed not less than 100 individual industrial relations activities being promoted as foreman duties. A listing of them would add two full pages to this article.

It is hardly necessary to point out that if these duties are being carried out by the foreman, the results of their performance show up in part in the published reports of the American Arbitration Association, the National Labor Relations Board, the National Mediation Board, as well as the Federal Mediation and Conciliation Service.

Year by year, each of these agencies report an increasing case load with a steady increment of the same troubles —discharge for cause, lesser forms of discipline, seniority, job classification, job tenure, sick leave, wages, transfers, job eliminations, etc. Meanwhile, where are the staff industrial relations people—people presumably "experts" on employe attitudes and response? They, of course, are available to every member of management for advice on any given problem having to do with employes.

The practical need of the industrial relations function is to return to activities that acknowledge and recognize the presence of each individual employe as different than any other and equally as important. A company may not be small in scope or size, but in its human relations it needs to operate as if it were; otherwise management may appear to employes as having abdicated its personal interest in people.

There are a number of industrial



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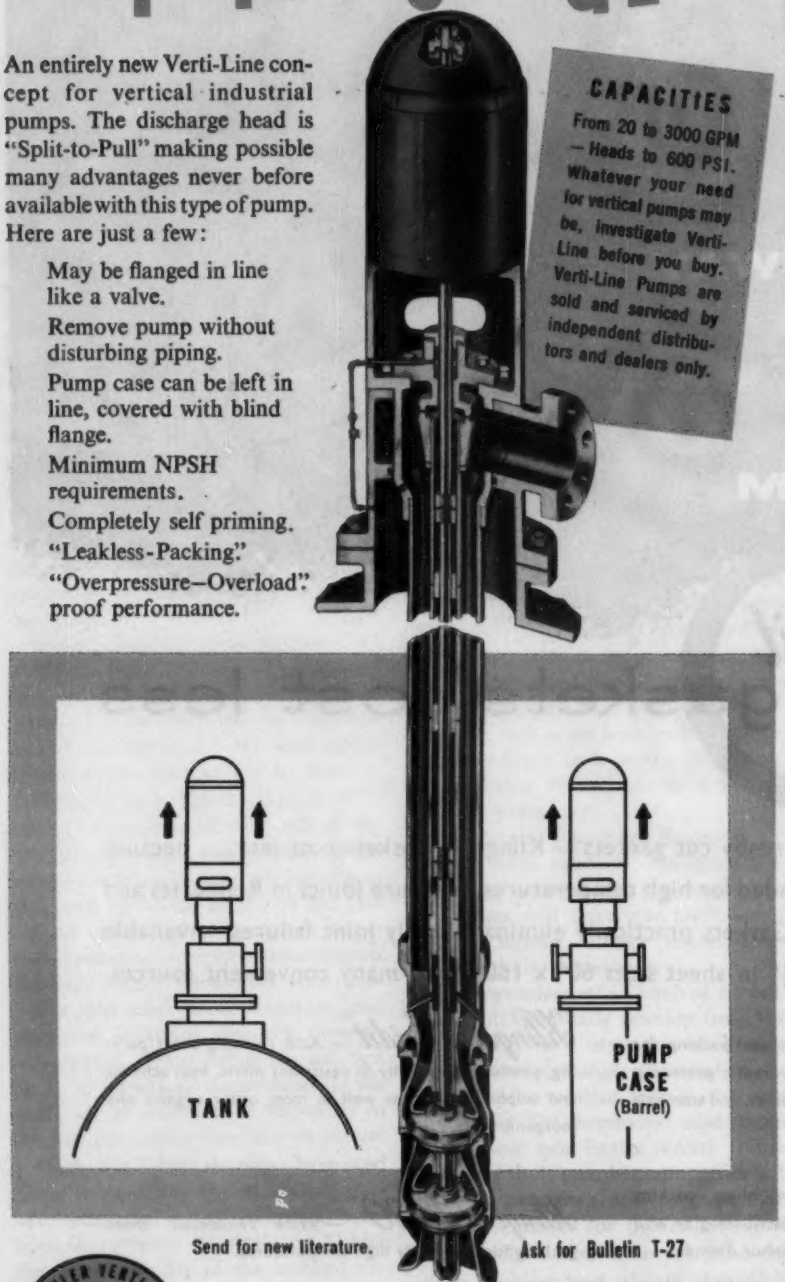

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As Management Sees It . . .

relations housekeeping activities that could be handled as effectively and more subjectively by functions other than the staff industrial relations department. Some excellent examples include:

- Suggestion systems.
- Bookkeeping and statistics of employe benefits.
- Job evaluation.

The objective should be to separate those industrial relations activities that deal directly with employes and employe relations problems from those that are mechanistic or that can be performed more productively elsewhere. What might be left would be a mobile, streamlined expertness as a service to management in conducting training courses, participating in labor negotiations, in anticipating as well as preventing employe disruptions and dealing directly with employe relations difficulties.

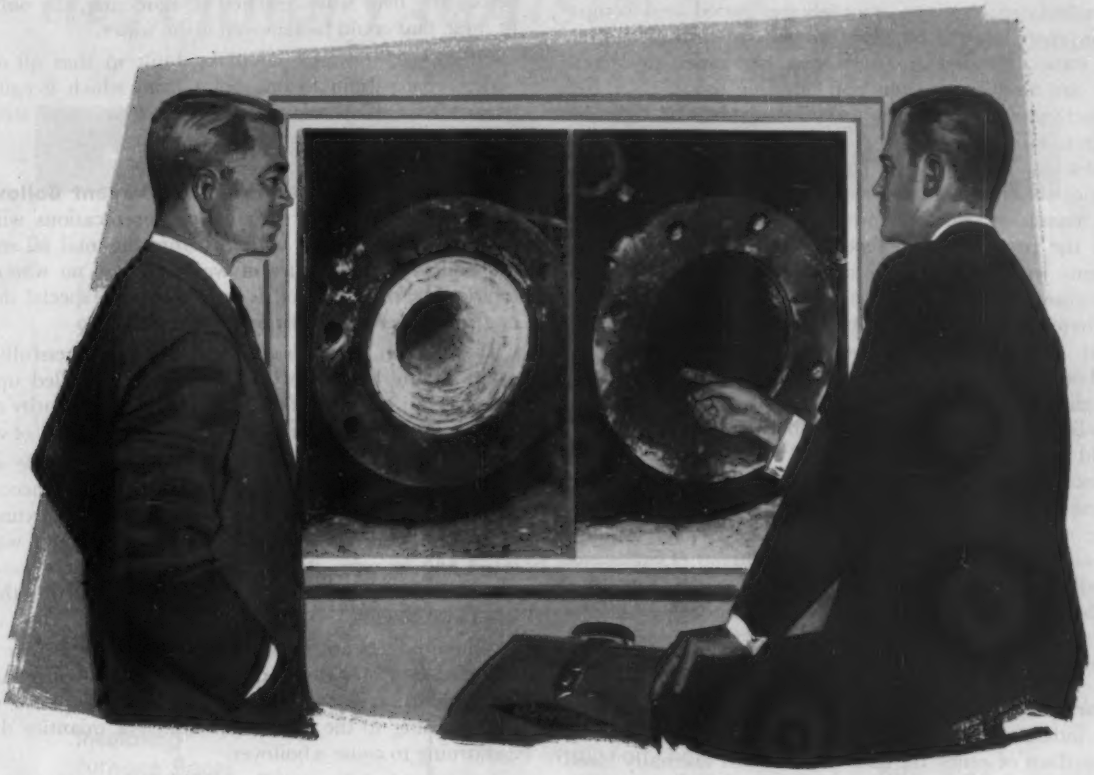
But, of course, industrial relations people require a personal compatibility with the responsibility for dealing in human problems. Many staff people are so deeply involved in arms-length programs that they have lost—if in fact they ever had—a feeling for human situations. It is not enough for a man to have managed programs to qualify him for a sensitive performance of industrial relations. With, however, an intuitive sense of human response and a friendliness that is warm and convincing, the industrial relations man has some basic tools to undertake his share of the responsibility.

The inevitable alternatives facing management in time are more employe relations upsets, followed by more unionization, and more government intervention followed by more socialistic forays.

Some well informed and articulate business leaders have stated a belief that the foundations of our business system are being weakened by an ineptness in handling employe relations. If this is so, the door to the solution of the human problems opens through the minds of the legions of "payrollers" and the answer rests within the sensibilities of individual employes.

To interpret Alexander Pope's comment on the proper study of mankind—the proper study of employe relations is the employe. ##

here's how Dowell chemical cleaning saved $71,000 and helped protect a plant profit!



A few months before their peak season, the operators of this plant decided their main water line might not supply the water necessary to meet peak demands. The line was cast-iron, 16-inches in diameter and over 7,000 feet long. Its original flow efficiency or "C" factor had been 105; scale build-up had reduced this to 72. To lay an auxiliary line would cost at least $85,000.

Dowell contracted to clean the pipe chemically for a little less than $14,000, and to restore a minimum of 50 per cent of the line's lost capacity.

This Dowell did, and more—increasing the "C" factor to 92! Enough water was immediately available for capacity operation. This saved the plant $71,000 and helped protect the company's annual profit.

The operating credit realized by this food processing plant, as a result of Dowell service, is similar to those realized by other Dowell customers—in the steel, paper, chemical, oil refining, power and allied industries.

Dowell engineers are experts in the use of solvents to remove scale and sludge—deposits that cut the throughput of product, process and steam generating systems. Dowell does the job, furnishing all chemicals, trained personnel, pumping and control equipment.

For specific information on how chemical cleaning can help you to greater profits, call the Dowell office nearest you. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

Have Dowell clean it chemically DOWELL

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How to Prevent Crude Oil Tank Fires

Continued from Page 101

burn to a boilover. Therefore, it is difficult to justify expensive added requirements on all tanks containing crude oil subject to boilover above the same type tanks containing refined oils which are not subject to boilover.

Wood and Composition Roofed Crude Oil Tanks—In isolated locations, a number of wood and composition roofed crude oil tanks are still in use. Also, there are some corroded and otherwise bad order steel roofs that are neither gas tight nor lightning proof.

Such tanks are subject to ignition either by lightning or iron sulfide spontaneous ignition. With the exception of floating roof rim fires, practically all crude oil tank fires of recent years have resulted from tanks of this type and condition. Furthermore, these tanks are so located that the providing of effective fire fighting devices and systems would be very costly and are not justified. In many cases these tanks are permitted to burn to a boilover.

There are two ways to prevent lightning ignition of wood and composition roofed crude oil tanks. One method is known as the Farady Cage. It consists of steel uprights welded or bolted to the shell of the tank at intervals around the tank. Wires between these uprights shield the roof from lightning strike.

Another method is the erection of masts that provide a cone of protection to tanks around it. For a more complete description of these methods, see "Code for Protection Against Lightning," National Bureau of Standards Handbook H40, Part III, Sept., 1944.

The best program for prevention of lightning ignition of these roofs is to replace them with all steel cone roofs or correct floating roofs.

Surface Static and Crude Fires—Experience and tests indicate that a static charge will not accumulate on the surface of crude oil faster than it can normally bleed off to the shell of the tank as may occur in refined products from pumping in turbulence. Therefore, surface static cannot be assigned as one of the causes of crude oil tank fires.

FIGURE 4—When the fire around this gasoline drum was extinguished and the drum cooled, the fire went out, not down into the drum.

The Problem of Boilover—With the all steel gas tight tank, the floating roof tank and modern methods of putting out crude tank fires, the problem of boilover has been reduced to isolated tanks. In many of these latter cases, the tanks are not lightning proof and the cost of fire extinguishment equipment cannot be justified.

To prevent one of these tanks from boiling over it would be necessary to change the heat wave characteristics of the oil, change its viscosity, or eliminate the water before the heat wave reached it. Evidently, the only one of these that could be removed is the water.

Of course, the tank could be built so that all of the water would drain to one point from which is could be pumped out. This might be cheaper than an all steel gas tight, or floating roof tank.

Use of Agitation Methods to Prevent Boilover—Agitation of crude oil by adopted specifications will not remove a heavy water bottom before the total oil reaches the boilover temperature of water. Where no water bottoms are carried and oil is kept mixed by special devices or air, boilover can be prevented.

If agitation methods are to be used successfully, the water at the bottom of the tank must be rolled up and steamed out at the surface before the total quantity of the oil reaches a temperature above the boiling point of water.

Recent tests indicate that with an appreciable water bottom this will not occur when air is injected according to the air agitation specifications designed to extinguish or control tank fires. In some tests the boilover was delayed and in some it was speeded up. In some instances the boilover appeared to be less violent and in others it was more violent.

Where mixers are installed in the tanks and there is no accumulation of water and emulsion on the bottom of the tank, agitation with devices or air will keep the water from settling to the bottom in sufficient quantity during its burning to cause a boilover.

In the case of gas tight and floating roof tanks the object is to save all the oil possible before it gets too hot to pump. Whether the oil can be pumped longer under agitation is not known. If there is a high heat wave travel rate, it is possible that agitation would allow more oil to be pumped. However, in the case of a slow heat wave travel rate the use of no agitation until the heat wave reaches the pumping out suction might allow the oil to be pumped longer.

These deductions are from a study of heat input when crude oil was burning under agitation control and tests on slow heat wave rate crude oil burning without agitation.

The oil industry is proceeding on a program which will continue to reduce the boilover problem to practical elimination. This will be accomplished by storing crude oil, even in isolated locations, in tanks which do not become ignited and in which the fire can easily be extinguished with portable equipment.

Many small tanks have already been equipped with extinguishing materials such as dry chemicals. These chemicals can be applied with portable devices and do not cause slopover regardles of the heat wave depth.

Part 3 will appear in the March PETROLEUM REFINER.

Refractory Castables are SPECIALIZED

Which are best to use in refinery units?

Naturally, the type of refractory castable selected depends upon the specific service. B&W makes a line of specialized refractory castables which are being widely used in catalytic reformers and catalytic cracking units, as well as in furnaces, ducts and stacks. For easy reference, here are some typical applications together with the recommended B&W Refractory Castables:

APPLICATION	DESIRABLE PROPERTIES	RECOMMENDED B&W CASTABLES
Linings of catalytic reformers	Extremely low iron content, extra high strength. Extremely low iron content, plus good insulation. Low iron content, high temperature use limit.	Kaocrete LI Kaolite LI Kaocast
Lining desulphurizers	Good workability	Kaocrete B
Transfer lines and regenerators of catalytic cracking units	Extra abrasion and erosion resistance.	Kaocrete D
Heads of reactors and regenerators	Plasticity, excellent workability.	Kaocrete B
Insulating furnace floors	Good insulation, light weight	Kaolite-20 Kaolite-22
Tube sheets	Good insulation, light weight	Kaolite-20 Kaolite-22
Burner blocks	High temperature use limit, refractoriness and spalling resistance.	Kaocast
Openings where doors and other points are subject to mechanical abuse	Extra abrasion and erosion resistance	Kaocrete D
Furnace doors	Good insulation, light weight	Kaolite-20 Kaolite-22
Ducts and stacks	Good insulation, light weight	Kaolite-20

Bulletin R-35 contains additional information on B&W Refractory Castables. Send for your copy.

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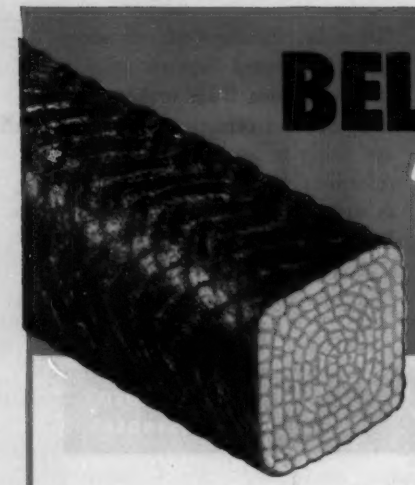

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Long fibre asbestos—each strand treated with a special compound to resist penetration and saturation—is braided, jacket over jacket. Guards against seepage and loss of product. Try it on your rods and plungers.

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For piston rods and valve stems handling oil, gasoline, benzol, naphtha, kerosene. **Catalog No. 54.**

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BELMONT

Make Your Bonus Plan Pay

Continued from Page 212

bonus payments to stockholding employes of the organization the hardest, but should be checked in all cases to be sure.

When a bonus paid to an employe bears a close relationship to his holdings in the company, the Internal Revenue Bureau may dis-allow part or all of the year-end bonus paid. Even though there is no relationship between the holdings of the stockholding employe and his year-end bonus, part of the payment may be dis-allowed.

To be on the safe side, you should base your year-end bonus payments on skill, training, responsibility, working conditions, profit contribution, and future prospects of the management men and the refinery.

Pay Bonus With Showmanship —This, of course, does not mean that you should hire a brass band when you present your key men their year-end bonus payments. But, a little quiet showmanship will make the key men feel that they are actually getting something over and above their regular salary as a bonus.

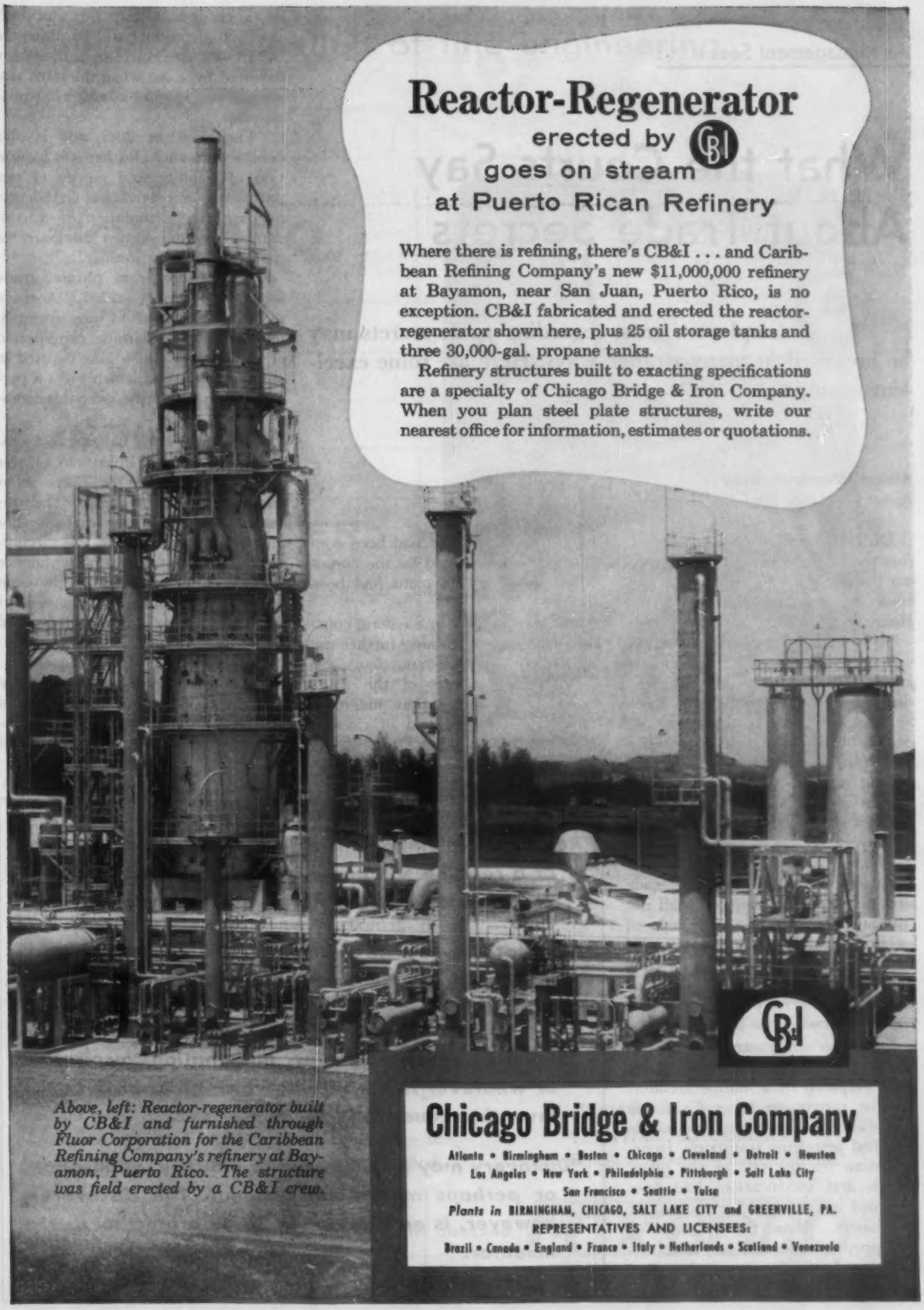
One organization, for instance, gives its year-end bonus payments in the form of certified checks. This makes the transaction seem more legal to the men and makes the payment more impressive.

Another firm always passes out its bonus checks in private. This provides an opportunity for the top executive to add a few personal words of "thanks" to the cash bonus he gives to his key employe. And, it tends to keep the amount of the bonus on a more confidential basis in the organization.

Contrast these ideas with a bonus that is included in the regular salary check. The man knows there is a bonus, but it takes a little figuring to arrive at the amount that is extra. And, with income tax and other deductions, the amount of the year-end bonus is not as impressive as when it is paid in a separate check.

Year-end bonus plans do not cost as much as you might think. And, when the long-term benefits of better employe relations is considered, the expense is changed to an investment in the future success of your refinery.

##



Reactor-Regenerator

erected by CB&I goes on stream at Puerto Rican Refinery

Where there is refining, there's CB&I . . . and Caribbean Refining Company's new $11,000,000 refinery at Bayamon, near San Juan, Puerto Rico, is no exception. CB&I fabricated and erected the reactor-regenerator shown here, plus 25 oil storage tanks and three 30,000-gal. propane tanks.

Refinery structures built to exacting specifications are a specialty of Chicago Bridge & Iron Company. When you plan steel plate structures, write our nearest office for information, estimates or quotations.

Above, left: Reactor-regenerator built by CB&I and furnished through Fluor Corporation for the Caribbean Refining Company's refinery at Bayamon, Puerto Rico. The structure was field erected by a CB&I crew.

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As Management Sees It . . .

What the Courts Say About Trade Secrets

Employers' trust regarding trade secrets may be breached in many strange ways. Here are some excellent examples.

Albert Woodruff Gray
Forest Hills, New York

IN THE DECISION of a case before the U. S. Supreme Court involving the disclosure by an employe of a trade secret of an employer, Justice Holmes once said:

"Whether the employers have any valuable secret or not the employe knows the facts, whatever they are, through a special confidence which he accepted. The property may be denied but the confidence cannot be. Therefore the starting point for the present matter is not property or due process of law but that the employe stood in confidential relation with the employers, or one of them.

"These have given place to hostility and the first thing to be made sure of is that the employe shall not fraudulently abuse the trust reposed in him. It is the usual incident of confidential relations. If there is any disadvantage in the fact that he knew the employer's secrets he must take the burden with the good."

Employers' trust can be breached in many ways. In one instance, plans were prepared by a marine architect for the conversion by a California corporation of dry cargo vessels to liquefied petroleum transports. In negotiations for the sale of the plans, details and specifications had been disclosed in confidence to prospective purchasers. After the negotiations had proved ineffectual and had been abandoned, the owner of the plans discovered that a vessel built according to the same plans had been constructed and launched by the corporation to whom the plans had been disclosed.

Suit was brought in a federal court and judgment restraining further use of the secret information was awarded the owners of the trade secret. In rendering that judgment the federal court said of circumstances of this character,

"There is no dispute but that one's intellectual product will be protected by a court in respect of a disclosure followed by a use when the same was obtained through a confidential relationship.

"The problem does not involve contracts, as such. Rather it is a question of validity and equity of one party's acts in receiving in confidence, pending the formulation of a contractual relationship, a disclosure of the other party's product."

Then of the legal phrase, trade secrets, the Court added, "A trade secret may consist of any formula, patent, device, plan or compilation of information which may be used in one's business and which gives a person an opportunity over his competitor.

"One point must be kept in focus. The novelty and invention in this type of case is not the same as is required for patentability. The underlying theory of the cases is that under a particular set of circumstances the relationship of confidence may arise by operation of law even though there is no express agreement that the matter divulged will be held in confidence."

Automobile Patterns—The same ruling was made in the decision of an action brought by a steel car manufacturer to prevent the pirating of

Regarding infringement of a patent for manufacture of a refining still and a secret arc welding process used to make oil pressure vessels, the courts say:

"A process may be maintained in secrecy and be entitled to protection even though invention is not present."

"Invention requires genius, imagination, inspiration or whatever is the faculty which gives birth to the inventive concept."

"Discovery may be the result of industry, application, or perhaps merely an accident. The discoverer, however, is entitled to the same protection as the inventor."

Unique combination of fine engineering and economy!

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M/44

INDICATING PRESSURE TRANSMITTER

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Any way you look at it, the new Foxboro M/44 Pneumatic Pressure Transmitter gives you an unmatched combination of fine engineering and economy. First; because it *is* an engineered instrument. There are no attachments or "makeshifts". Second; because it utilizes standard Foxboro parts throughout—parts which have been performance-proved in thousands of successful installations of other Foxboro Instruments. And this means not only top performance, but easier servicing and stocking as well. Third; calibration is simple, right in the field, because the M/44 is "convenience-designed" by men with years of experience in every phase of instrument design and application.

In appearance, too, the M/44 has unmistakable Foxboro quality. Features like the high-legibility indicator scale, the compact drawn-steel case with tough polyester plastic cover. It's the neat, high-efficiency, low-cost pressure transmitter for centralized operation or control. All standard ranges.

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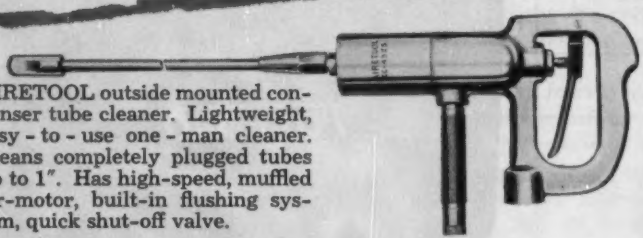
NEW . . . AIRETOOL Internal Tube Cutter. New single-stage, air-driven motor is designed and built by AIRETOOL. Quickly, inexpensively removes damaged or leaky condenser tubes. Optional electric motor for use where air supply is not available.



AIRETOOL outside mounted condenser tube cleaner. Lightweight, easy - to - use one - man cleaner. Cleans completely plugged tubes up to 1". Has high-speed, muffled air-motor, built-in flushing system, quick shut-off valve.

AIRETOOL Automatic Tube Expansion Control . . . automatically, accurately rolls tube joints to proper tightness. Portable unit goes right to job site.

AIRETOOL Tube Removal Tools are great for retubing a bundle. Quickly and efficiently remove tubes and tube stubs from condenser tube sheets.

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Write for illustrated Bulletin #59 on condenser tube maintenance tools

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As Management Sees It . . .

drawings and blueprints. In that instance large sums of money had already been spent in the designing of a particular style of car. It had been the practice of the manufacturer to send its purchasers blueprints of cars and car parts to facilitate the ordering of the cars and repairs.

In its decision of the suit brought to prevent the piracy of this competitor the Pennsylvania court said:

"It matters not that the parts of the cars were not protected by patents and that the process of manufacture was not a secret one. A certain amount of publicity is inevitable in any manufacture but an unlocked door is not an invitation to a passerby or to the servant of the household to help himself. Neither does a manufacturer abandon his property in a design by delivering it or a copy to another for a restricted purpose, nor by a limited publication.

"His property rights will be protected in such cases and he will be protected against a breach of trust, confidence or contract and especially will he be protected against a breach of confidence existing between employer and employe."

Rotary Pump Patterns—Another incident of this character was involved in a controversy before the New York courts many years ago. The inventor of a rotary pump had taken his patterns to a pattern maker for repair. While the pump had already been sold on the market by the inventor the patterns which provided for the expansion and contraction in the casting of the metal parts, had been kept secret by the inventor.

Later the owner of the patterns sued to prevent their use or disclosure by the pattern maker who, in violation of the confidence of their owner, had made a duplicate set. In its award to the inventor of an injunction against this disclosure the court said:

"If a valuable medicine not protected by patent is put upon the market anyone may, if he can by chemical analysis and a series of experiments, or by any other use of the medicine itself, aided by his own resources only, discover the ingredients and their proportions.

"If he thus finds out the secret of the preparation he may use it to any extent that he desires without danger

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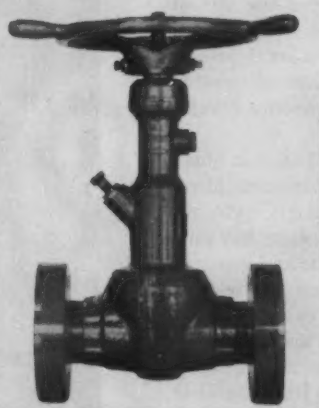
WHY? Because, if you are one of the thousands who use Orbit Forged Steel Rising Stem Valves, experience has proved that these valves are built for trouble-free performance — very few ever need to be repaired. Therefore . . .



THIS AD IS DIRECTED TO THE VERY FEW ORBIT VALVE CUSTOMERS WHO HAVE VALVES THAT NEED REPAIR!

On an average less than ½ of 1% of Orbit Valves are returned to the factory for repair. This includes valves damaged by improper handling, installation or maintenance. However, if an Orbit Valve needs reconditioning, we urge the user to take advantage of our exchange valve repair system by returning the valve to the factory.

Facts about Orbit exchange-valve repair system . . .

Under Orbit Valve Company exchange valve repair system and subject to the conditions outlined here, the customer may return any damaged Orbit Forged Steel Rising Stem Valve to our Factory at Tulsa, Oklahoma or to any one of our Branch Warehouses, accompanied by a letter giving return instructions, valve serial Number and source of Purchase Order to be furnished to cover reconditioning service and receive in exchange for the damaged Orbit Valve a valve of the same size and test pressure from our reconditioned stock, for which we charge only 35% of the current cost of a new valve. Customer pays freight both ways.

All damaged valves received by us under the above conditions are subject to factory inspection to determine extent of damage. In those few cases where damage to the valve is extensive and it is estimated that repair charges will exceed 50% of the cost of a new valve, the exchange will not be made on a 35% basis, instead, the customer will be immediately notified by letter containing our recommendations and stating the amount of additional repair charges that will be necessary to return the Orbit Valve to first class condition.

All reconditioned Orbit Valves are given a new Valve guarantee and are, therefore, covered by our "Warranty"

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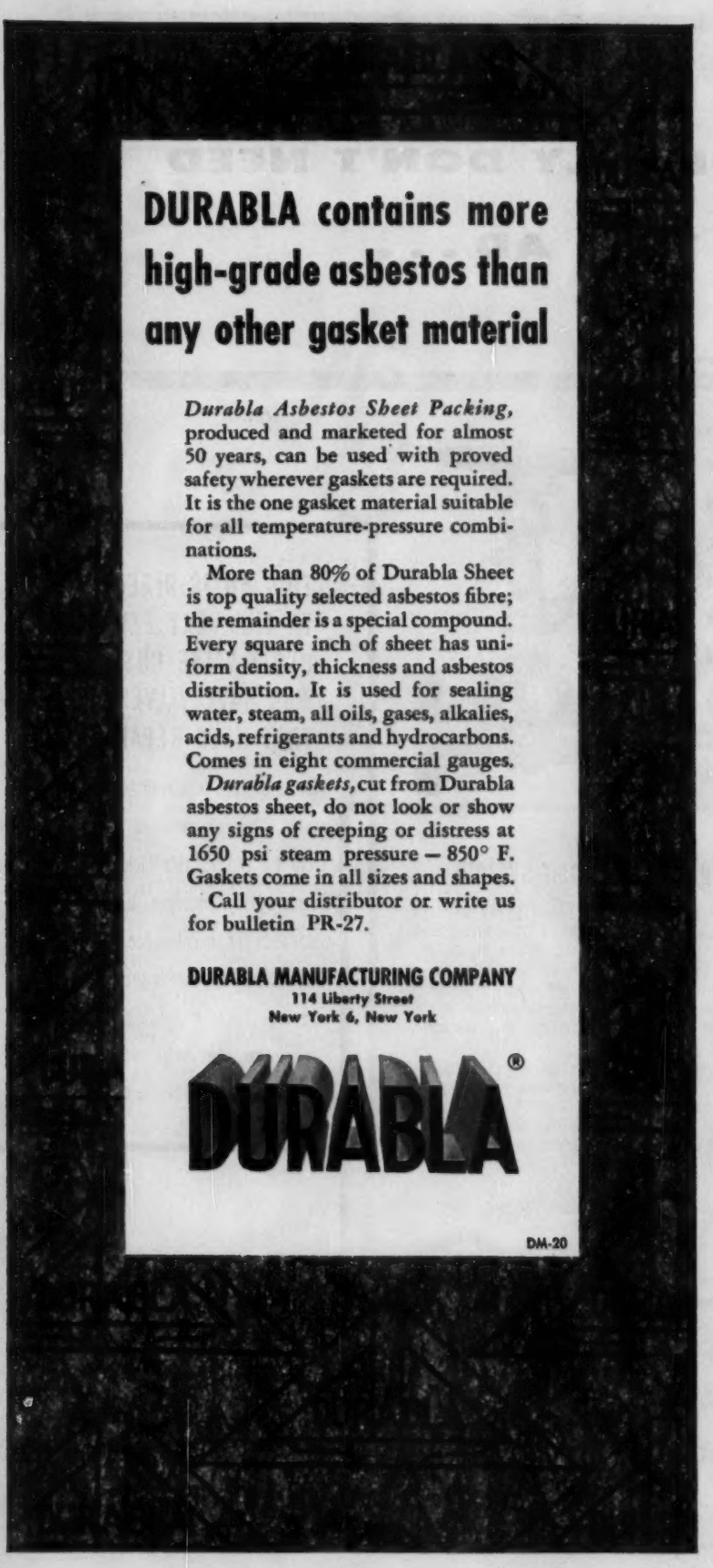
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of interference by the courts. But because this discovery may be possible by fair means it would not justify a discovery by unfair means, such as the bribery of a clerk who in the course of his employment had aided in compounding the medicine and had thus become familiar with the formula.

"We think that the patterns were a secret device that was not disclosed by the publication of the pump and that the owner was entitled to the preventative remedies of the court. While the pattern maker could lawfully copy the pump because it had been published to the world, he could not lawfully copy the patterns because they had not been published but were still in every sense the property of the inventor, who owned not only the material substance but also the discovery which it embodied."

Refining Stills—Some years ago suit was brought in federal court in Ohio, not only for the infringement of a patent for the manufacture of oil refining stills, but also for the fraudulent appropriation of a secret arc welding process used in the fabrication of oil pressure vessels.

In distinguishing between the law governing mechanical inventions and that governing trade secrets or secret processes, that court said:

"A process may be maintained in secrecy and be entitled to protection even though invention is not present. Quite clearly discovery is something less than invention. Invention requires genius, imagination, inspiration or whatever is the faculty which gives birth to the inventive concept. Discovery may be the result of industry, application, or perhaps merely fortuitous. The discoverer however is entitled to the same protection as the inventor.

"Facts of great value may, like the lost purse upon the highway, lie long unnoticed upon the public commons. Hundreds pass them by, till one more observant than the rest makes the discovery. It is idle to say that, in the eyes of the law, interest may not in such case follow discernment."

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DU PONT *Petroleum Chemicals* NEWS

One of a Series of Bulletins for the Petroleum Industry

FEBRUARY 1957

Critical lubricating problems indicate growing market for estersil greases

There is a steadily growing number of industrial processes where lubricants are exposed to water and intense heat, combined with vigorous working. These applications demand lubricant performance beyond the capability of ordinary greases.

By using Du Pont Estersil GT (grease thickener), several industrial lubricant makers are meeting this demand for better greases with considerable success. Here is a typical example of how estersil can help grease suppliers meet unusually difficult lubrication requirements.

Grease life extended

A pigments manufacturer had been using a conventional grease for lubricating chemical dryer racks. This grease lost its lubricating qualities after one trip through the drying oven where the temperature averaged 120°C. This made the racks (weighing 2500 lbs.) difficult to roll manually, and resulted in excessive downtime for frequent greasing.

To increase the efficiency of this process, an estersil-based grease was tried. Success was immediate. The racks rolled easier and downtime for greasing was cut in half.

Safety increased, too

In addition to the economy realized through reduced downtime, this company got an extra dividend in increased safety. With the conventional grease, an accident occurred in which the operator's hand and wrist were jammed because the rack would not roll easily. And the danger of this—plus physical strain—occurring frequently was great. But, by making the racks roll more easily, the estersil grease eliminated this hazard.

Broad market

There are many other similar applications where greases made with Du Pont Estersil GT can best meet the critical demands of high-temperature operation, or where high water resistance is needed. They have, for example, increased efficiency in enamelling-oven conveyor setups having operating temperatures as high as 500°F.

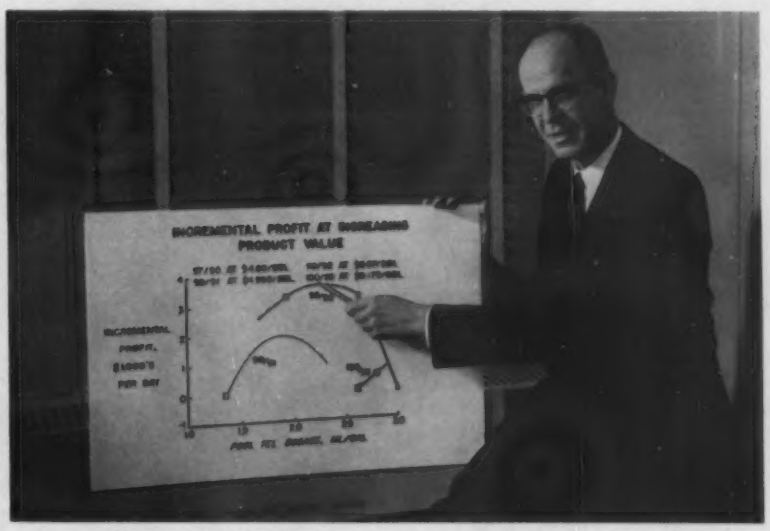
Farm tractors, mining machinery, and heavy construction equipment represent another big market for estersil-based greases. In these applications they give better protection against dirt, water and rough going . . . and help to cut maintenance costs by increasing lubrication efficiency and by reducing downtime for greasing.

Any of our sales offices will be glad to furnish more information on Du Pont Estersil GT and how it can increase grease sales and profits potential.

How economic study of operations helps increase refinery profits

by Jack S. Bellah

A modern refinery of course offers many process and gasoline blending possibilities. And selecting the combination of the variables that will produce desired product quality most economically requires a careful analysis of plant operating and laboratory blending data. Refiners who do not have their own staffs to do this work are invited to consult with Du Pont.



MANY YEARS' EXPERIENCE in refinery technology enables Mr. Bellah to make a practical, accurate economic-analysis of many refinery operations.

Those having their own economic study group may want to compare their results with ours to see if perhaps a different viewpoint can lead to further economies.

A Du Pont service

As a supplier of tetraethyl lead, we at the Du Pont Company are continuously analyzing typical refinery operations to determine their effect on the additives business. In discussing our general conclusions with people in the industry, we have been asked in several instances to make such an analysis for a specific operation. We are always glad to provide this help as a service to the refiner.

To illustrate how this service has

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OVER

DUPONT *Petroleum Chemicals* NEWS

CONTINUED *Refinery Profits*

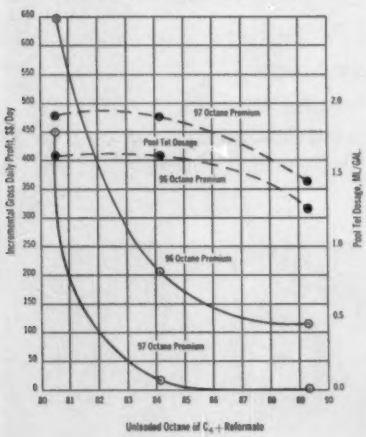
been used, here are the results of one such investigation:

A case history

A small modern refinery recently added a catalytic reformer to the processing facilities. Three reformer operating conditions were compared—low level, design, and high level severity. A fourth case, involving jet fuel production and non-operation of the reformer, permitted calculating the break-even gross value of those gasoline components which went into the jet fuel production. Two premium gasoline octane levels also were to be considered.

The results are shown in the graph at left and in the table below.

FIGURE 1
Economic Study of Catalytic Reforming Operations



Profit up $400 per day

At the platformer design operating condition – 90% C_4 plus recovery of 84.2 clear octane product – the daily gross profit was calculated to be some $400 less than that obtained from an operation yielding 91% C_4 plus recovery of 81.1 clear octane product. This, as you can see in the table at left, was indicated at both 96 and 97 octane premium levels.

On the other hand, a disadvantage was indicated for operation at any higher severity level than the design condition. This led to the general conclusion that an even lower level of operating severity than the one estimated might be still more attractive.

Available to you

By comparing notes with you on the most economical processing steps and reforming severity, in relation to your own individual stocks and market requirements, there is a chance that we can provide a service to your own process engineering group. Just drop us a line if you would like us to discuss this service with you.

TABLE 1
Economic Study of Catalytic Reforming Operations

	Design	Lo Level	Hi Level	Down
Reformer Operation C_4 + Clear Research Number	84.2	81.1	89.3	Jet Fuel
Pool TEL Dosage Ml/Gal.				
96 Premium	1.625	1.65	1.275	2.685
97 Premium	1.895	1.92	1.44	2.97
Product Realization, $/CD	38880	39205	38625	30885
Variable Costs, $/CD				
96 Premium	2965	2850	2805	2965
97 Premium	3160	3045	2920	3125
Net Gross Realization, $/CD				
96 Premium	35915	36355	35820	27920
97 Premium	35720	36160	35705	27760
Incremental Gross Profit, $/CD				
96 Premium	210	650	115	
97 Premium	15	455	0	
Jet Fuel Break-Even with Best Performance Case, $/CD				
96 Premium – 11.2¢/Gal.				8435
97 Premium – 11.1¢/Gal.				8400

Residual fuel sludge problems solved with Du Pont FOA-2

At a midwestern manufacturing plant, the oil pump of an underground heavy-oil storage tank became ineffectual because of a sludge accumulation blocking the supply line. Five gallons of Fuel Oil Additive No. 2 were added to the tank, and the fuel was recirculated for several days. In this way, enough sediment was removed from the tank to permit operation of the pump.

Not only had FOA-2 dispersed the sludge—but the filters *remained* clean afterward. And the oil containing the sludge was burned in a normal manner without any harmful effect on the combustion system. Also, this simple and inexpensive method eliminated the hazardous and expensive job of lowering a man into the tank to remove the sludge mechanically.

Another FOA-2 Economy

At a New Jersey chemical plant, periodic cleaning of a heavy fuel-oil storage tank was required. In addition, large particles of solid material on the strainer before the pump caused an increase in the pump suction vacuum. On several occasions, pump suction was lost completely.

Outside service companies had previously been employed for a similar cleaning job. This time, however, it was decided to try another method. One hundred pounds of FOA-2 per 1,000 barrels were put in and the oil was recirculated.

Examination of the strainers showed no sludge-binding material. As a result, pump suction vacuum dropped to normal where it stayed. To maintain these improvements, FOA-2 is now being used regularly in a concentration of 35 pounds/1,000 barrels.

These case histories show how existing sludge problems can be easily solved and—better—prevented, through the addition of FOA-2 at the refinery.

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OVER

Serial No. A3667

Printed in U. S. A.

What's Happening . . .

. . . in the Industry

API Refiners Announce Philly Schedule

Motor fuels of tomorrow and latest progress of 'Silent Sam' will highlight program at mid-year meet.

Members of the petroleum-refining industry will gather in Philadelphia this spring for the American Petroleum Institutes' Division of Refining semiannual meeting.

Eleven technical sessions and the traditional dinner meeting have been scheduled for the four-day gathering which opens May 13 in the Sheraton Hotel, and continues through May 16.

Of the many subjects on the program, air polution and motor fuels are expected to hold exceptional interest for the industry and the public alike. Several months ago, the Franklin Institute announced that it had developed a unique tool for ultra-scientific detective work in the atmosphere. Nicknamed "Silent Sam" (Petroleum Refiner, Nov. '56, p. 269) the apparatus has enabled researchers to isolate a mysterious "Compound X" which in turn has been identified as a probable culprit in the formation of smog. The latest institute findings on this subject will be brought to light in a paper presented by W. E. Scott.

The motor fuel session will tend to be somewhat futuristic, as it will see presentation of two papers dealing with the motor fuels of tomorrow.

Emphasizing the serious mood of the meeting is the fact that night sessions will be held on three of the four days. The customary dinner session will occupy the third consecutive evening for refiners attending the meeting.

Preliminary program for the 22nd midyear meeting is as follows:

MONDAY, MAY 13, 1957

9:00 a.m. Corrosion

Presiding: D. T. Shaw, The Atlantic Refining Co., Philadelphia.

Session developed by Carl H. Samans, Standard Oil Co. (Indiana). "Corrosion in Catalytic Reform- and Associated Processes," panel report of the subcommittee on Corrosion, Committee on Refinery Equipment. E. B. Backensto, Socony-Mobil Oil Co., Inc., Paulsboro, N. J. "Some Typical Cases of Corrosion in Platformers," D. J. Bergman, S. A. Bjorkman, Universal Oil Products Co., Des Plaines, Ill. "Corrosion Control in Ultraformers," A. Dravnieks and Carl H. Samans, Standard Oil Co. (Indiana), Whiting, Ind. "Hydrogen Attack of Steel in Refinery Service," A. R. Ciuffreda, Esso Research and Engineering Co., Linden, N. J. "Corrosion in Crude Processing—Low pH vs. High pH," J. A. Biehl and E. A. Schnake, The Ohio Oil Co., Robinson, Ill.

2:00 p.m. Electrical Equipment

Session developed by L. M. Goldsmith, The Atlantic Refining Co., Philadelphia. "Mineral Insulated (M.I.) Cable," C. A. Jordan and T. J. Massar, General Cable Corp. "Air-Break vs. Oil-Break Electrical Equipment for Use in Refineries," L. T. Ellis and W. R. Morton, General Electric Co. "Development and Design of Electrical Equipment for Use in Areas Defined as Class II in API

It's 100 Now!

The Standard Oil Company (Indiana) engineering research department has produced its 100th new instrument to improve petroleum products. The instrument, an end point recorder, will be used in the company's Sugar Creek, Mo., refinery. Samuel A. Montgomery, Standard Oil manufacturing vice president, congratulated Dr. S. Frederick Kapff (second from right), inventor of the recorder. Also pictured are George W. Watts (left), director of engineering and engineering research, and Dr. Robert B. Jacobs (right), technical director of the engineering research department.

The end point recorder measures the temperature at which the heaviest components of a petroleum fuel vaporize. The recorder is installed at the processing unit and allows the operator to test samples frequently. Testing is completely automatic after a sample is put in the instrument. Proper vaporization and burning of the heaviest parts of the fuel require precise control of all components. End point measurement provides the control necessary to produce fuels having maximum quality and performance.

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Texaco Research has scored "firsts" in many fields. Its highly-developed manpower and facilities work in many ways to serve all industry everywhere.

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2:00 p.m. Analytical Research

Presiding: Dayton H. Clewell, Socony Mobil Oil Co., Inc., New York.

Session developed by B. J. Heinrich, Phillips Petroleum Co., Bartlesville, Okla. "Spectrophotometric Determination of Nitric Oxide or Nitrogen Dioxide in Nitric Acid Plant Tail Gas," Francis J. O'Hara and Orville N. Hinsvark, The Girdler Co., Louisville. "Determination of Traces of Water in Hydrocarbons in the Gasoline Boiling Range—Sample Handling and Interferences," J. West Loveland, Thomas B. Webster, Charles P. Hablitzel and George W. Reed, Sun Oil Co., Marcus Hook, Pa. "The Analysis and Biological Assessment of Petroleum-Based Insecticides," A. D. Harford, E. Thornton and N. J. McTaggart, The British Petroleum Co., Ltd., Middlesex, England. "Polarographic Estimation of Thiophenes and Aromatic Sulfides in Petroleum," Harry V. Drushel and James F. Miller, Mellon Institute of Industrial Research, Pittsburgh. "Rapid Chromatographic Analysis of Soap-Thickened Greases," George W. Powers, Jr., and Frank J. Piehl, Standard Oil Co. (Indiana), Whiting. "The Sequential Probability Ratio Test as a Novel Statistical Procedure in Analytical Chemistry," Anthony Bartholomay and Bert L. Vallee, Harvard Medical School, Cambridge, Mass.; and Peter Bent, Brigham Hospital, Boston. "A Rapid Method for the Determination of Zinc in Lubricating Oils," T. L. Marple, G. Matsuyama, and L. W. Burdett, Union Oil Co. of California, Brea, Calif.

7:30 p.m. Analytical Research

Presiding: L. W. Moore, American Oil Co., New York.

Session developed by B. J. Heinrich, Phillips Petroleum Co., Bartlesville, Okla. "Determination of Five to Seven Carbon Saturates in Petroleum by Gas Phase Chromatography," F. T. Eggertsen and S. Groennings, Shell Development Co., Emeryville, Calif. "A Wet-Ash Spectrochemical Method for the Determination of Trace Metals in Petroleum Fractions," J. Hansen and C. R. Hodgkins, Esso Research and Engineering Co., Linden, N. J. "The Determination of Trace Quantities of Hydrocarbons in the Atmosphere," E. R. Quiram, Esso Research and Engineering Co., Linden, N. J. "The Determination of Bromine Number by Automatic Electrometric Titration, E. H. Unger, Socony-Mobil Oil Co., Inc. "The Determination of Oil in Refinery Effluent Water—A Report of the API Subcommittee on Refinery Effluent Water Analytical Methods," J. B. Rather, Jr., chairman of the subcommittee, Socony-Mobil Oil Co., Inc., Brooklyn.

TUESDAY, MAY 14, 1957

9:00 a.m. Air Pollution

Session developed by W. H. Clausen, California Research Corp., San Francisco. "Further Developments in the Chemistry of the Atmosphere," W. E. Scott, The Franklin Institute, Philadelphia. "Damage to Vegetation by Polluted Atmospheres," John T. Middleton, professor of plant pathology, University of California, Riverside. "Automobile Exhaust Gas—Its Contribution to Air Pollution," C. M. Heinen, chairman, CFR Group on Composition of Exhaust Gas, Chrysler Corp., Detroit.

2:00 p.m. Fuels

Session developed by J. B. Duckworth, Standard Oil Co. (Indiana), Whiting. "Factors in Designing Gasolines for Modern Engines," C. A. Hall, H. A. Toulmin and T. W. Warren, Ethyl Corp., Detroit. "Road Octane Numbers of Tomorrow's Fuels in Tomorrow's Cars," J. S. Bellah, J. J. Greytak and W. E. Morris, E. I. du Pont de Nemours and Co., Inc., Wilmington, Del. "A Refinery View of Fuels for the Future," Humble Oil and Refining Co., Baytown, Texas.

2:00 p.m. Training

Session developed by W. M. Reed, The Atlantic Refining Co., and W. E. Zimmerman, Sun Oil Co., Philadelphia. "The Importance of Spiritual Values to the Well-Balanced Manager," O. A. Ohmann, The Standard Oil Co. (Ohio), Cleveland. "The Supervisor's Role in the Recognition and Adjustment of Problem Cases in the Refinery," John J. Thorpe, Esso Standard Oil Co., New York.

7:30 p.m. Handling Kerosine

Presiding: A. P. Frame, Cities Service Oil Co., New York. Session developed by W. W. Scheumann, Cities Service Research and Development Co., New York. "A Report on the Program to Determine the Hazards Involved in Handling Kerosine," Cities Service Research and Development Co., New York.

WEDNESDAY, MAY 15, 1957

9:00 a.m. Instrumentation

Session developed by George N. Ehly, The Atlantic Refining Co., Philadelphia. "Intrinsic Safety," Lee E. Chucker, Fielden Instrument Co. Automatic logging equipment, use of radioisotopes in instrumentation.

2:00 p.m. Isomerization

Presiding: J. S. Worden, The Texas Co., New York.

Session developed by Cecil L. Brown, Esso

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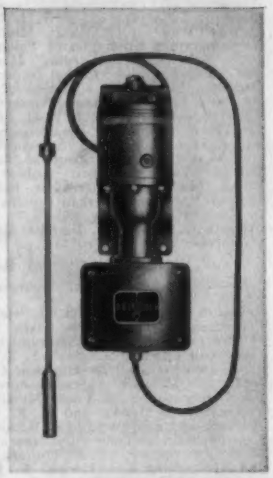

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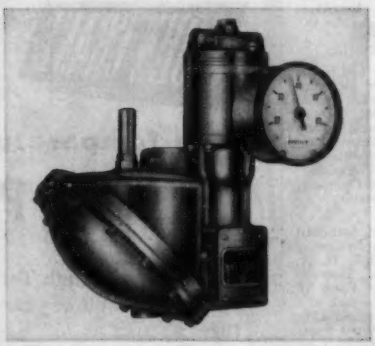

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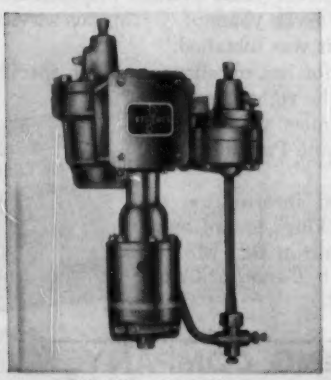

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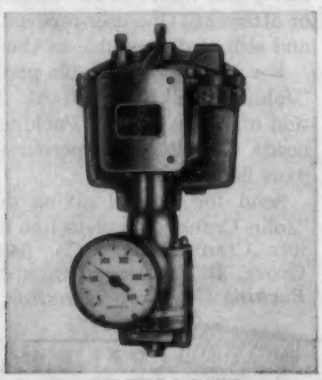

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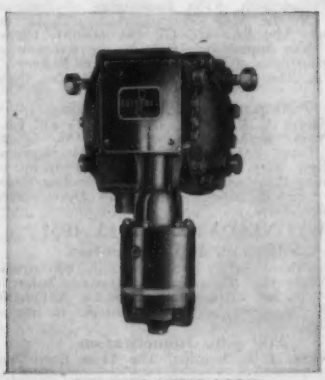

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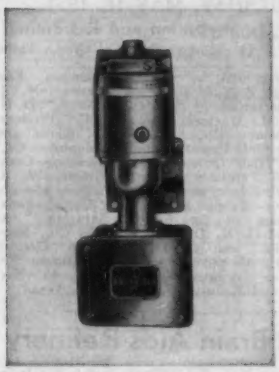

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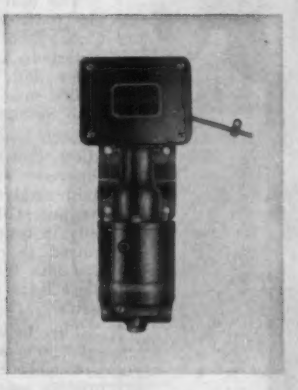

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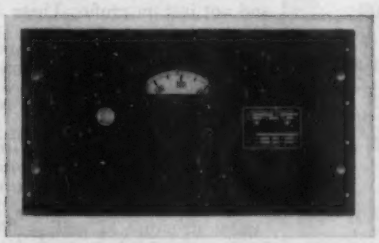

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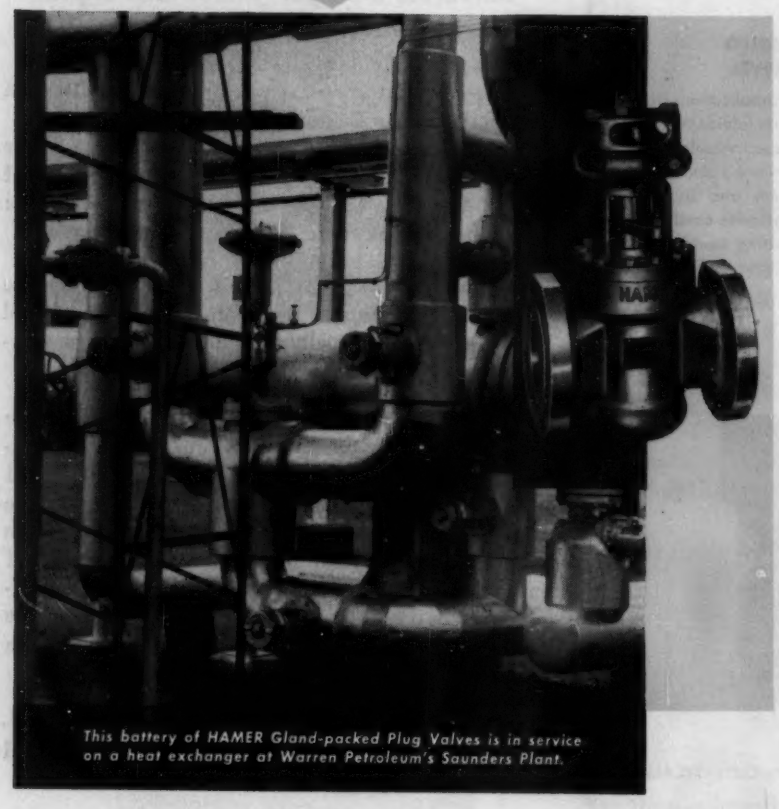

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What's Happening . . .

Research and Engineering Co., Linden, N. J. "The Isomate Process," Standard Oil Co. (Indiana). "Isomerization Adds to Your Octane Picture," H. R. Crane, G. R. Worrell and J. Ozawa, The Atlantic Refining Co., Philadelphia. "Isomerization by the Iso-Kel Process," The M. W. Kellogg Co., Jersey City.

7:00 p.m. Dinner Session

Presiding: H. W. Ferguson, vice president for refining, American Petroleum Institute; Humble Oil and Refining Co., Houston.

Session developed by C. H. Thayer, Sun Oil Co., Philadelphia. (The details of the program will be announced later).

THURSDAY, MAY 16, 1957

9:00 a.m. Isomerization and Reforming

Presiding: J. O. Timms, Gulf Oil Corp., Philadelphia.

Session developed by Cecil L. Brown, Esso Research and Engineering Co., Linden, N. J. "Hydro-Isomerization by the Penex Process," D. H. Belden and V. Haensel, Universal Oil Products Co., Des Plaines, Ill., and W. C. Starnes and R. C. Zabor, Gulf Research and Development Co., Pittsburgh. "High Octane Motor Blending Components from Pentanes," Harold Shalit, W. S. Briggs, F. W. Kirsh, and J. B. Maerker, Houdry Process Corp., Marcus Hook, Pa. "Dehydrogenative Reforming of Low-Boiling Saturates," A. Schneider and C. K. Donnell, Sun Oil Co., Marcus Hook, Pa.; and D. H. Stevenson, Houdry Process Corp., Marcus Hook, Pa. "Platinum Reforming on a Commercial Scale," H. C. Nix, Humble Oil and Refining Co., Baytown, Texas.

Built-In Brain Aids Refinery

The first oil refining unit with built-in electronic brains is under construction in Cuba, Esso Research and Engineering Co. reported. A general purpose analog computer and log sheet printer will be installed next spring at the Belot refinery of Esso Standard, S. A., near Havana.

Each hour the computer will give operating crews the information needed to supervise and analyze conditions in the fluid catalytic cracking unit. In the past, computers have been used by refineries only in central offices. Engineers were required to regularly inspect units, obtain the data by various calculations and feed these facts into the computer back in the office.

The Belot computer and printer will make the data available on the spot, and will permit more efficient running of process units than is possible by conventional manual calculation.

Management Awards Given

A rating of Excellent Management for 1956 has been awarded to 20 oil companies by the American Institute of Management. Companies are rated by the Institute on every function of management and not just on profits. There are ten basic categories of management performance used to study Canadian and American business. An Audit committee makes the final ratings, using a point schedule which requires 7500 of a possible 10,000 points for Excellence.

The companies are studied from the point of view of their economic justification as well as their treatment of shareowners, customers, and the public. Their capital structure as well as the customary figures are closely scrutinized, but the greatest weight is given to the evaluation of the executive team.

Those companies receiving the award were: Amerada Petroleum Corp.; The Texas Co.; Sun Oil Co.; Standard Oil Co. of California; The Standard Oil Co. (Ohio); The Standard Oil Co. (New Jer-

MOUSETRAP, STEAM TRAP, SEWER TRAP

...it makes no difference

. . . the world *won't* beat a path to the door of the man who builds a better one *and then doesn't advertise it* so that people will know about his product, know where it can be bought and how much it costs.

Advertising benefits the buyer, too. It tells you the product story, makes it easy for you to buy. Even more important to you, advertising leads to mass production and volume sales . . . which means lower costs and lower prices.

Yes, "Advertising Benefits You" . . . 'specially business-paper advertising.

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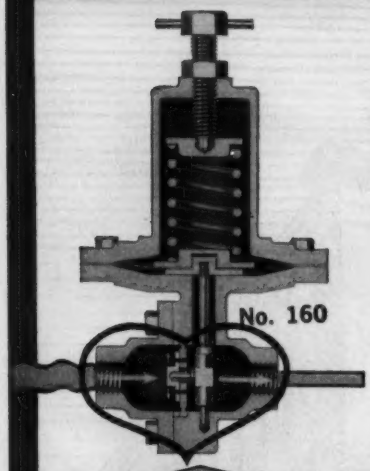
pressure reducing
VALVE*



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the heart of the OPW-JORDAN Valve

THE DIFFERENT AND IMPROVED WAY TO CONTROL PRESSURE.

- DEAD END SHUT-OFF
- WIRE DRAWING MINIMIZED OR ELIMINATED
- SELF-LAPPING SEAT
- NO HUNTING . . . SHORT STROKE FOR IMMEDIATE RESPONSE

The unique Sliding Gate seating design and exclusive features of this valve are responsible for its outstanding performance and long dependable service life. Metallic diaphragm, metal to metal seals, no packing or gaskets to deteriorate, straight-thru body and durable construction assure precise regulation with immediate response and unusual sensitivity under hard, constant use.

*Daily replacing troublesome pilot operated valves.

For interesting facts, write for Bulletin J-160.

JORDAN CORPORATION
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What's Happening . . .

sey); The Standard Oil Co. (Indiana); Socony Mobil Oil Co., Inc.; Shamrock Oil and Gas Corp.; Shell Oil Co.; Seaboard Oil Co.; Phillips Petroleum Co.; The Ohio Oil Co.; The Louisiana Land and Exploration Co.; Humble Oil & Refining Co.; Gulf Oil Corp.; Continental Oil Co.; Cities Service Co.; The Atlantic Refining Co.; and Creole Petroleum Corp.

Stanolind Takes New Name

Stanolind Oil & Gas Co. has changed its name to Pan American Petroleum Corp. This action came following the merger of Stanolind and Pan American Production Co. late last month. Both companies are subsidiaries of Standard Co. (Indiana).

E. F. Bullard, Stanolind president, said the change is being made to eliminate the possibility of confusion in the public mind between Stanolind Oil and Gas Co. and other oil companies with names similar to or having a significance similar to the Stanolind name. Another reason for the change is to give the Tulsa-based firm a name more indicative of the geographical extent of its operations.

Several months ago, Indiana-Standard announced that it planned to merge nine of its subsidiaries into four companies. Other moves by the parent will consolidate American Oil Pipe Line Co. into Service Pipe Line Co., and Pan-Am Southern into American Oil Co.

The organizations three chemicals companies, Indoil Chemical Co., Pan American Chemical Co., and Hidalgo Chemical Co. have already been merged into Amoco Chemicals Corp.

O. K. to Protest UOP Sale

Nine independent oil firms have won another victory in their fight to stop the sale of Universal Oil Products Co. The Appellate Division of the New York Supreme Court upheld a previous decision by ruling that the independents had a right to argue whether or not UOP may be sold under New York state law (PETROLEUM REFINER, December, page 296; October, page 254).

Independent Refiners Association of America and others have intervened in the proposed sale of UOP by claiming that such a sale might drive them out of business. UOP'S facilities, which are presently available to all refiners regardless of size, might be cut off, they say, if the firm is sold to a large petroleum concern.

Universal Oil is the major asset of Petroleum Research Fund, a trust managed by Guaranty Trust Co. which wants to sell UOP in order to diversify the trust's holdings.

Corrosion Course Begins

Corrosion engineers from industry around Shreveport, La., are cooperating with Centenary College in offering a night school course entitled "Introduction to Corrosion and It's Control."

The course carries three hours academic credit with classes meeting each Thursday night on the campus. It started January 31, with final examination being scheduled for May 16.

Free World Gains Oil Ground

From the end of World War II to the end of 1955, the Oil Industry increased its Free World gross investment in fixed assets by 174 percent. During this same period, consumption within the Free World just increased by 100 percent. This information was disclosed in a report prepared by two members of the petroleum department of the Chase Manhattan Bank.

It estimates that the industry laid out $56 billion in capital expenditures in the postwar period with $18 billion going to foreign areas, and $38 billion or 68 percent remaining in the U. S. Production got 59 percent of the total, transportation 13 percent, refining 16 percent, and marketing 12 percent.

As a result of these expenditures, gross investment in fixed assets rose from $23 billion at the end of 1945 to $63 billion at the close of 1955, with $40 billion of it in the U. S.

Of the $23 billion invested abroad, U. S. companies contributed $8 billion, for 54 percent participation in Canada, 61 percent in Venezuela, 26 percent in Western Europe, 47 percent in the Middle East, and 22 percent in other countries.

The report also showed that U. S. investment abroad in the Free World represented 55 percent of the production, and 40 percent of the refinery runs in 1955.

Fears Price "Squeeze Play"

A new four point program calling for the substitution of petroleum products for the crude oil now being shipped to Europe has been proposed by The Independent Refiners Association of America.

Chances are that the program will receive the polite attention of the Interior Department's Oil and Gas Office, but the possibility is slight that the government will take any action. Most observers feel that the U. S. is not authorized to carry out the policies advocated by independent refiners. Also, domestic crude producers and major oil companies with overseas refineries can be depended upon to join forces against the plan.

In a letter to OOG Director Hugh A. Stewart, IRAA President M. H. Robineau wrote that the "independent refining segment of the U. S. oil industry is in real danger of being squeezed out of existence" because the present European emergency has resulted in increased production and higher crude prices while there is an over supply of gasoline and other products on U. S. markets.

He further pointed out that Europe's greatest needs are for products rather than for crude, and his four point program advocated:

1. To apply a petroleum administrator for European supply with adequate powers and an adequate organization.

2. Establish as government policy, a program to meet the shortage of petroleum products in Europe by supplying products in quantities required, and not crude oil from this country.

3. "Carry out this program by employing existing powers. . . ."

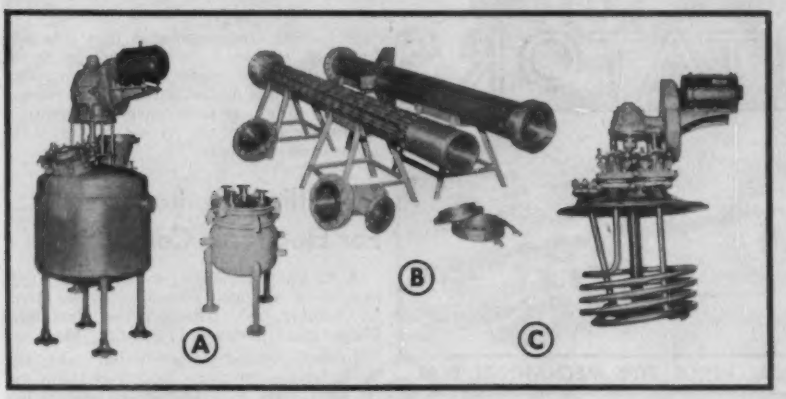
4. Work with MEEC and other such organizations as are appropriate to see that individual company actions are taken in a manner constant with the declared objectives of the government.

As yet, no reply has been drafted, but an Interior Department spokesman pointed out that the government exercises no con-

Corrosioneering News

Quick facts about the services and equipment available to help you reduce corrosion and processing costs.

Published by The Pfaudler Co., Rochester, N.Y., U.S.A.



A. Pfaudler titanium reaction kettles for high-temperature processing.
B. Pfaudler packed floating head titanium heat exchanger.
C. Pfaudler titanium loop coil for use in titanium reactor.

When should you use titanium process equipment?

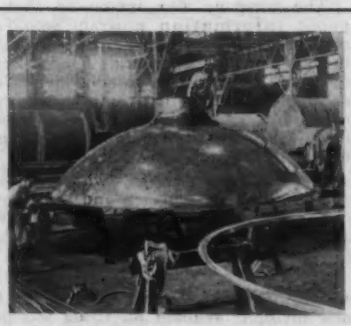
Titanium, a relatively new material of construction, shows great promise in reducing corrosion costs under severe chemical conditions.

As corrosioneers, Pfaudler has studied its characteristics, developed welding techniques, designed and built quite a range of titanium process equipment. Some are shown above and others are being fabricated now.

Because production costs of titanium have been greatly decreased, titanium should now be considered as a material of construction wherever it is economically feasible to do so. It has superior resistance to nitric acid solutions at high temperatures, chlorinated organics and inorganic chloride solutions, and shows excellent resistance to mixtures of sulphuric and nitric acids and also to aqua regia.

There are also other materials which provide excellent chemical resistance, among which is Pfaudler glassed steel. Each case should be considered on its own merits.

Our main point is this: When you are up against any kind of a corrosion problem, Pfaudler is ready and anxious to give you the benefit of its 73 years of experience in designing and fabricating equipment that will do the best job at *the lowest over-all service cost*. If titanium is indicated, you can rely on Pfaudler know-how to do just that. Your inquiries are welcomed.



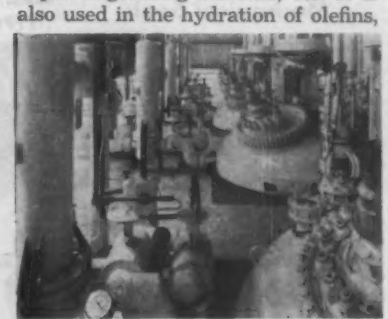
Copper and copper alloy equipment . . . For services involving acid solutions of low oxidizing capacity, copper and copper alloys may be the best answer to your problem. Pfaudler's long experience in building copper vessels and heat exchangers assures you of top-quality engineering and workmanship. You will also find Pfaudler prices competitive. Let us quote on your requirements for equipment of this type.

Glassed steel for the petroleum industry

The petroleum industry, like chemical processing, finds in glassed steel equipment a material of construction which is proving most economical in the battle against corrosion.

Great improvement in the resistivity of Pfaudler glass and its application to many different types of open hearth steel designs, are mainly responsible for this trend. Pfaudler glass, now resistant to all acids (except hydrofluoric) and to alkaline solutions to pH 12 at 212° F., provides about as much flexibility as you can find in any one material of construction.

Used in the form of reactors, columns, settlers, mixers, storage tanks, pipe, fittings and valves, Pfaudler equipment is giving excellent service for reactions involving hydrochloric acid, chlorinated solvents, pesticides, vapor degreasing solvents, etc. It is also used in the hydration of olefins,



to prevent corrosion by sulphuric acid, in certain phases of producing cumene-derived phenol and by-product acetone in polyester resins and synthetic fibres.

Installations of Pfaudler glassed steel polymerizers are so numerous that standardized designs have been developed. Glassed steel can be cleaned quickly after each run; a build-up of product within the vessel is easily prevented.

In petroleum refining operations, corrosion during crude distillation has been minimized. Glass helps to prevent passage of hydrogen to the steel surface, eliminating atomic hydrogen attack. There are other applications too numerous to include here. May we send you more information?

For more data on advertised products, use Readers' Service Cards, last page.

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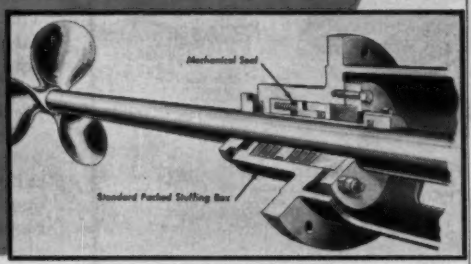
International

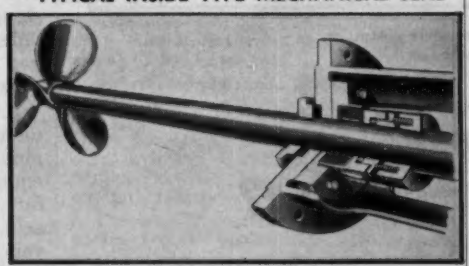
AGITATORS

With Mechanical Seals



TYPICAL INSIDE TYPE MECHANICAL SEAL

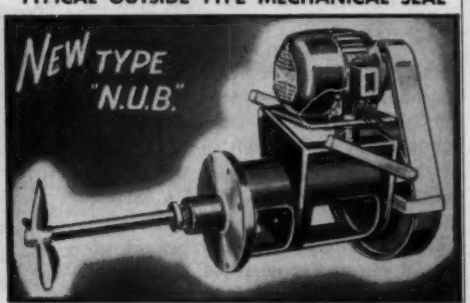
Specifically designed to resist corrosion, high temperatures and pressures —to seal toxic or flammable fluids perfectly without losses,—to reduce fire hazard, power, labor and repair costs, with much longer service and fewer shut downs. Certain applications show reduction of friction up to 83% over conventional packings— No scoring of shafts—permits specially designed sealing of gritty and abrasive fluids.



TYPICAL OUTSIDE TYPE MECHANICAL SEAL

New "International" Mechanical Seals

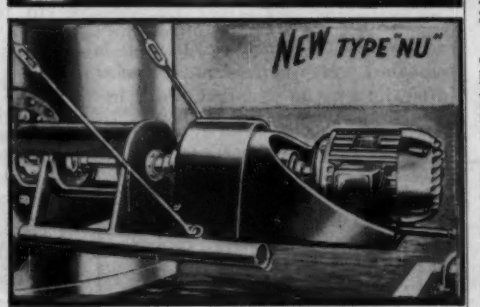
INTERNATIONAL can furnish either standard packed Stuffing Box or Mechanical Seals.—On Side Entering Mixers either Seal can readily be converted to the other, if desired, as shown in upper right hand illustration.



SHUT-OFF CONNECTION on side entering mixers allows repacking or replacement with either standard Stuffing Box or Mechanical Seals with a full head of liquid, without appreciable leakage.

Technical Bulletins Available

INTERNATIONAL stands back of its product with expert engineering service help when you need it. Over a Quarter Century of complete coverage in Petroleum Agitation—Remember to investigate "INTERNATIONAL" when you want prompt action and Guaranteed performance—Ask for Special Bulletins on Top Entering, Side Entering and Portable Mixers today.



INTERNATIONAL ENGINEERING, INC.

DAYTON 1, OHIO

NEW YORK 15 Park Row WO-rth 2-2580

CHICAGO 3454 W. Lake Street Sacramento 2-6750

What's Happening . . .

trol over the production of crude or the manufacture of products. It is out of the question to expect an official decision as to whether petroleum products or crude should be shipped to Europe since the Interior Department does not have the authority to establish government policy where private industry is concerned.

Robineau also contended that it would be much cheaper to send petroleum products rather than crude. "The basic conclusion," said the letter is that "Europe can buy net products with fewer dollars than Europe can buy the crude oil to make these same products."

$2-Billion Market Seen For Electronic Computers

A $2-billion market for electronic data-processing systems was forecast by John E. Johnson, sales director for Datamatic Corporation, Newton Highlands, Mass.

Johnson, basing his prediction on studies made by his company, said that there are at least one thousand customers losing money every day they struggle along without one.

Each of these, he says, has the sales volume and complex record-keeping that justify the purchase of an electronic data-processing system. This would add up to a $2-billion market for the 15 major producers now making electronic "brains."

Industrial, business, financial, service and government organizations make up the market for such systems, Johnson said. He calculates that a giant "brain" becomes a good buy when annual gross sales are 100 times the "annual" cost of the system. Thus, a $36-million-a-year company could use a data-processing system fitted with enough units to bring the total price to $2 million.

Esso Creates New Division

Esso Research and Engineering Co. has set up a special Technical Information division to speed its scientific work and conserve technical manpower. The new division will include a corps of specialists to better cope with gathering, evaluating and channeling technical information to scientists in both Esso Research and Jersey Standard affiliates around the world.

The company estimated that the volume of technical literature in the United States has been more than doubling every ten years. Esso Research alone prepares and issues to affiliates more than 1000 technical reports yearly.

The company also announced that its public information program would be closely coordinated with the new technical internal information work. This is being done to "make more broadly known the accomplishments of its scientists and engineers and to acquaint the public more fully with the contributions of research to the nation's economy and defense."

Charles E. Starr, Jr., who has been public relations manager and was previously an assistant director of research, was appointed manager of Technical and Public Information.

Also, William T. Knox, an assistant research director, was named director of the new division; William M. Craig was promoted from assistant director to director

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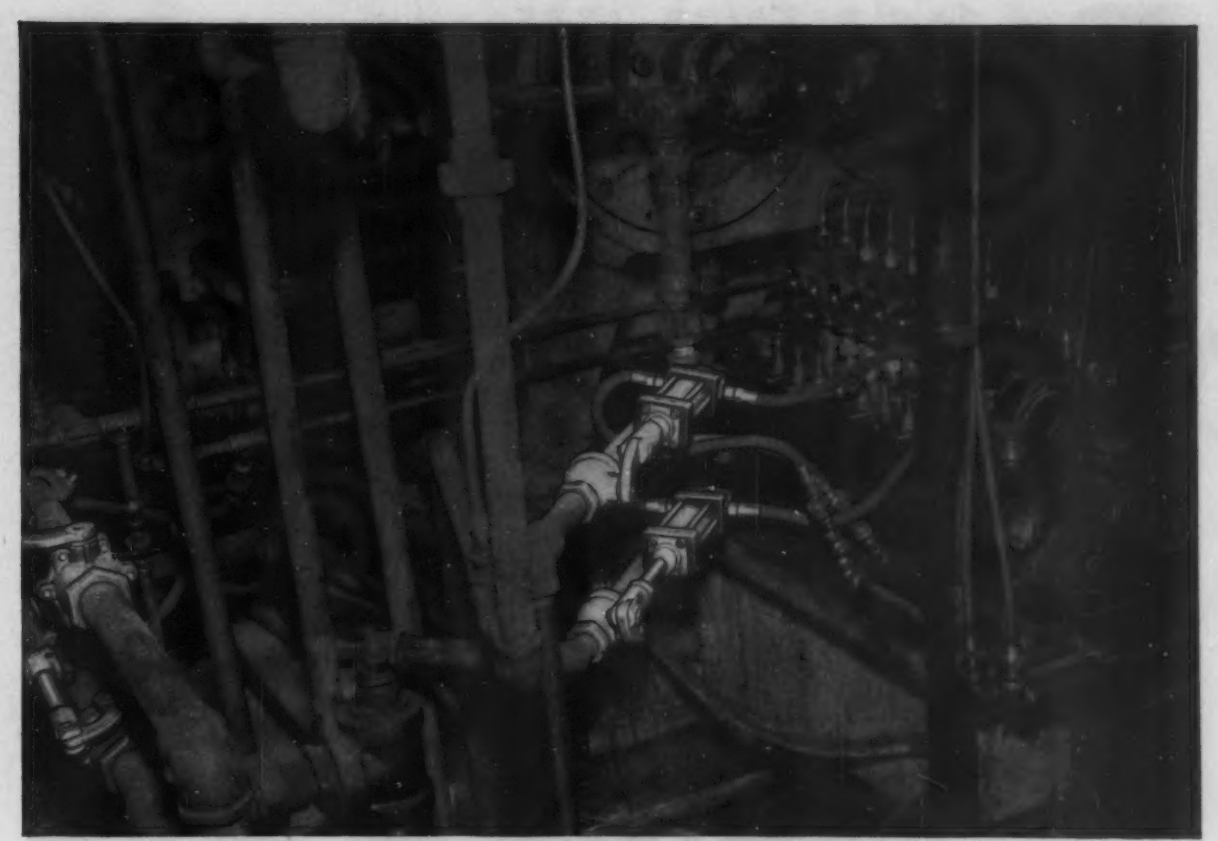
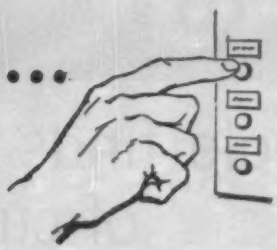


When a valve location plays hard-to-get like this one, a remote-controlled Rockwood Air-Operated Ball Valve is the absolutely dependable solution.

It's remote-controlled... It's ready for automation!



... a Rockwood Air-Operated Ball Valve will do its job anywhere a man can't reach, anywhere remote-control is required.

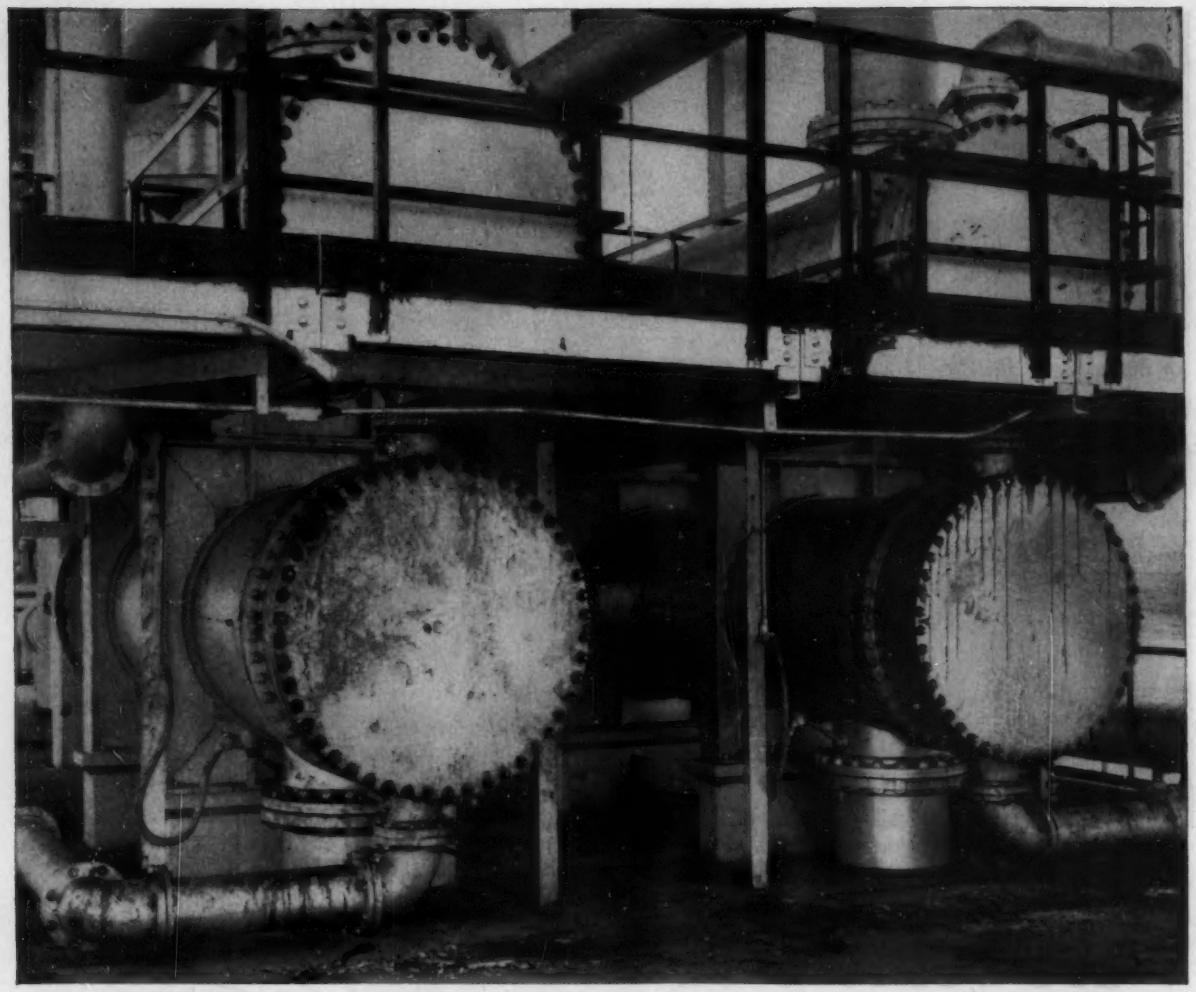
One or more of these valves, all operating smoothly and efficiently, can be controlled from a central control board. The valve is adaptable to a wide range of controls. The air-operation unit can be mounted in four different positions around the rugged, dependable Rockwood Full Round Flow Ball Valve.

This perfect solution to a common problem comes as a package. The package includes a Rockwood Ball Valve, a cylinder and mounting brackets. Sizes run from ½" through 2" in bronze, and 3", 4", 6" and 8" in cast steel.

Write today for full information. ROCKWOOD SPRINKLER CO., 1289 Harlow Street, Worcester 5, Massachusetts. Distributors in all Principal Industrial Areas.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW



Creole finds No Measurable Corrosion of cupro-nickel tubing after 6½ years in salt water condenser

When designing a new refinery in Venezuela, the Creole Petroleum Corp. specified cupro-nickel tubing to assure long life for its salt water condensers.

After 6½ years' service at their Amuay Bay Refinery, inspection reports on 70-30 cupro-nickel tubing in overhead salt water condensers (top) showed *no* measurable corrosion, except for slight impingement caused by fouling.

Tubing in the crude-overhead partial condensers (bottom) also 70-30 cupro-nickel exhibited no corrosive attack.

Elsewhere in the plant, 90-10 cupro-nickel tubing in fuel oil cooler shows no measurable corrosion *after four years' service.*

If operating conditions cut the life of your tubes, and cut into profits as well, nickel-containing alloy tubes may be the solution to your problem. Write for 28-page illustrated brochure, "Alloys for Heat Exchange Problems." Tells you what alloys have been successful under severe operating conditions.

INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening . . .

of Public Relations; Gordon Duncan, formerly assistant manager of the Office of Scientific Liaison, was named assistant director of Technical Information; and Howard Tate, who has been head of the Information Staff in New York and who plans to retire this year, was appointed consultant to the Technical Information division.

Refining Sales Climb Higher

The Federal Trade Commission has reported that petroleum refining sales for the third quarter of 1956 were up one percent over the previous quarter, while taxes after profits were up two percent for the same period. These figures are in contrast to a general decrease in all manufacturing industries of three percent and 13 percent, respectively.

Third quarter petroleum refining sales were $6.03 billion, compared with $6 billion in the second quarter. Profits after taxes totaled $669 million as compared with $657 million.

New Bill Talks 'Gas' Blends

A new bill has been introduced to Congress by Senator Capehart (R-Ind.) to create a multimillion dollar government agency to find and develop new uses for agricultural products, including the blending of gasoline with alcohol made from grain.

Capehart, whose bill would put an "Industrial Agricultural Products Agency" under the Agricultural Department, asked for an annual appropriation of $100 million for the new agency. He said $1 million would be needed for the remainder of the current fiscal year which ends June 30.

A similar bill was introduced last session by the Indiana lawmaker, but Congress took no action.

Railroads Eye 'Economy' Fuel

Use of "economy" oil fuels might eventually enable U. S. railroads to cut their annual $350 million diesel fuel bill as much as 10 percent, it was reported at the annual meeting of the Society of Automotive Engineers in Detroit.

The report, issued jointly by Esso Research and Engineering Co. and the New York Central Railroad, covered cooperative studies on how best to use these economy fuels in railroad diesels.

Economy fuels were defined as a blend of low-cost residual oils and more expensive distillate oils. Normally, only distillates are used in diesel operation.

In stationary locomotive tests conducted at the New York Central's engine shop in Harmon, N. Y., Esso Research scientists found that a distillate blend containing 75 percent of the cheaper residual oil performed "satisfactorily" in high-power operation.

A dual fuel system was installed to overcome unsatisfactory performance at low-power operation, including idling. The system makes it possible to switch over to regular diesel fuel during low speeds.

Studies are now covering road operation in heavy freight service. Initial results are

This tube support is 21'6" long; 6'7" wide and weighs 8900 pounds. It looks like a single casting. Actually it is made up of three sections welded together in zig-zag strips across the face. It's a Duraloy HH casting destined for an oil refinery cracking still.

Welding is assuming greater and greater importance in the production of high alloy castings. Often it is the only way to produce large tonnage or unusually shaped pieces. During our many years of experience in producing both high alloy static and centrifugal castings, we have developed sound welding techniques for such castings. Carbon steel welding techniques won't serve. It takes special know-how for chrome-iron and chrome-nickel.

You can rest assured that if the chrome-iron or chrome-nickel castings you order from us require any welding, it will be done skillfully.

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening . . .

reported as "good," although the tests will continue for an extended period.

Texas Butadiene Relocates

Texas Butadiene & Chemical Corp., has moved its executive and sales offices from the Gulf Building, Houston, to permanent location in suite 440 in the recently completed Bank of the Southwest Building, Houston. The plant and plant administrative offices are located on the San Jacinto River 5 miles north of Channelview and 16 miles northeast of Houston.

W. German Output Climbs

During 1956, West German refineries turned out about 11.34 million tons of products. This is about 12 percent more than in 1955 the Association of West German Crude Oil Producers and Processing Industries reported. The increase was considerably smaller than those of recent years, it noted, and this was partially due to smaller crude supplies because of the Suez crisis.

A total of 3.49 million tons of crude oil processed by refineries last year came from domestic sources. This meant that the 30 percent share of domestic crude in total supplies was maintained.

Independents to Get Voice

The appointment of three new consultants to the Middle East Emergency Committee have been confirmed by Interior Secretary Seaton. This is in answer to complaints from independent refiners and producers (PETROLEUM REFINER, January, page 283) over not being represented in the program for supplying oil to Western Europe.

The refiners represented are Glenn E. Nielson, Husky Oil Co., and Reid Brazell, Leonard Refineries, Inc. Producers will be represented by Cruce C. Clardy, Clardy and Bennett, Dallas.

Institute Volume Increases

Research volume soared at Armour Research Foundation of Illinois Institute of Technology during its 1955-56 fiscal year.

The Foundation's gross volume totaled $11.91 million—about $1 million more than during the prior year, and more research projects were conducted than ever in the foundation's 20 years.

A record 691 programs, 179 more than during 1954-55, were conducted during the year. Of this, 393 were for industry and 298 for government. To meet this increasing demand for its services, the Foundation announced a $5 million building program during the year.

Erratum

V. B. Volkening

R. H. Bacon

Page 124's barricade against gremlins failed miserably in our January issue. There was a general mixup and the three accompanying photos, with correct names, are being shown along with our apologies. Messrs. Bacon and Volkening, with The Dow Chemical Company, Freeport, Texas are the authors of the article, "Color Can Revolutionize Your Plant" (page 120, January, 1957) and Mr. Nelson, with Phillips Chemical Company, Bartlesville, Okla., is the author of an article "Lubrication Scheduling Cuts Costs" which will appear in an early issue of PETROLEUM REFINER.

C. R. Nelson

W. Coast Refiners Form

A California Independent Oil Institute has been formed to emphasize the significance of independent oil companies to the general economic well being of the state.

George T. Goggin, executive vice president of Douglas Oil Co. was named presi-

The Dean Hill vertical, molten sulphur pump equipped with a DH vertical steam turbine drive. (Available also with vertical hollow or solid shaft motor drive.)

Like all Dean Hill products, this sulphur pump incorporates all of the features to give you years of trouble-free operation. Complete steam-jacketed line shaft and discharge column assures free flow at all times. Actual liquid sulphur lubricates bearings and shaft damping bushings. The Dean Hill sulphur pump is a compact, self-contained, rigid, smooth-running mechanism capable of superior service at all times. For complete information write today, without obligation.

DEAN HILL PUMP COMPANY
Pump and Turbine Engineers Since 1893
Indianapolis 7, Indiana

SALES OFFICES IN PRINCIPAL CITIES.

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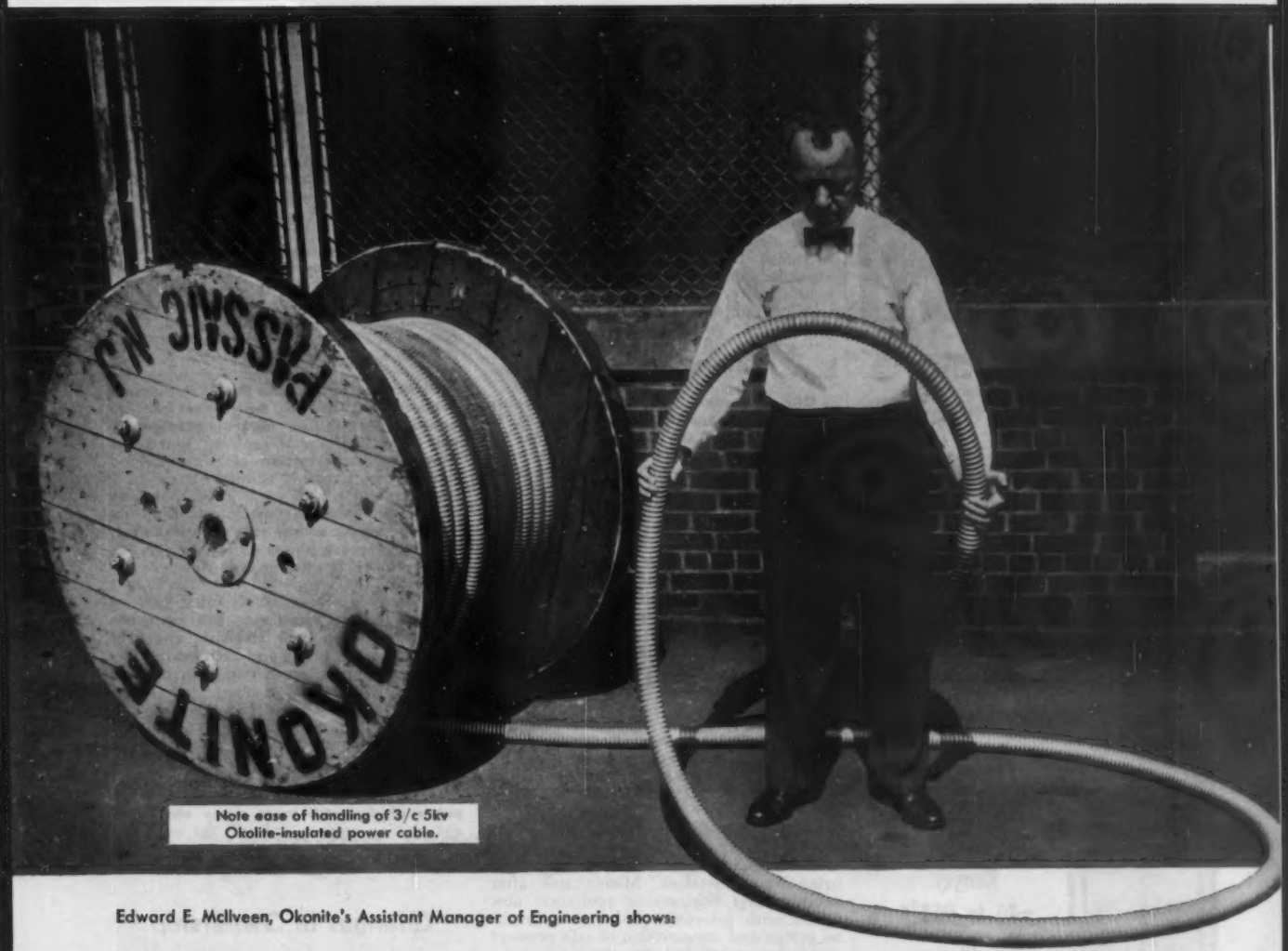


Note ease of handling of 3/c 5kv Okolite-insulated power cable.

Edward E. McIlveen, Okonite's Assistant Manager of Engineering shows:

Why Loxarmor is the low cost alternative to conduit

Rubber-insulated Loxarmor Interlocking S-shaped armor cables provide an ideal combination of flexibility, light weight and mechanical strength. Where rigid conduit is not desired, Loxarmor is the No. 1 alternative for either power or control circuits. Here's why:

Material and installation costs are lower. Eliminates conduit and related installation procedures such as making bends and using pull boxes. It is especially useful in cramped quarters.

Circuits are easily added or re-routed—usually trained in trays or racks, Loxarmor cables can be easily moved.

Easy accessibility reduces down-time—permits quick inspection. Can be installed indoors and outdoors.

Loxarmor occupies less space—not much more than half the space is required for multiple Loxarmor circuits vs. circuits in conduit.

Loxarmor can be supplied with the strip-insulated insulations Okolite oil-base or Okonex butyl-base; with extruded Keystone or Watertite insulations; or with varnished cambric—all depending upon your installation conditions and voltage requirements.

Loxarmor is available in galvanized or stainless steel, aluminum, bronze or copper armor. May be obtained with either copper or aluminum conductors. For further information write for Bulletin PR -1090. The Okonite Company, Passaic, N. J.

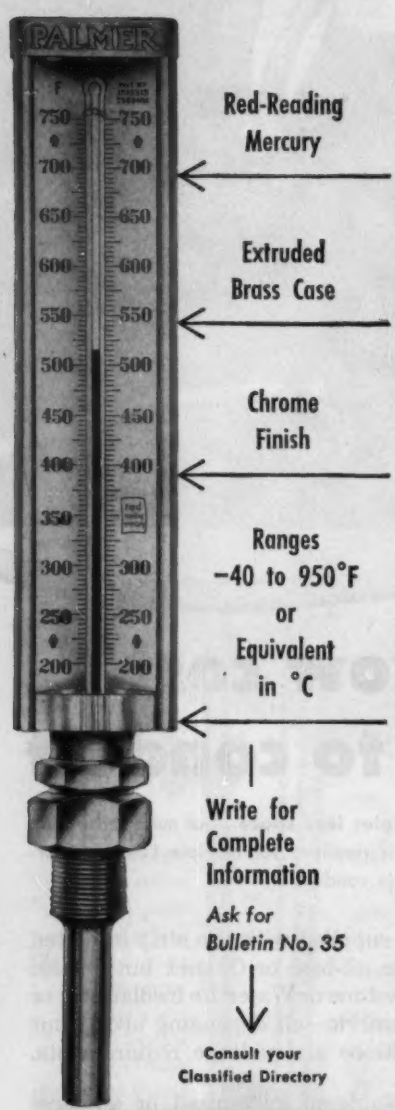
where there's electrical power... there's **OKONITE CABLE**

4161-A

Today's Modern Industry
Demands a Modern Thermometer

PALMER

RED-READING MERCURY THERMOMETERS



Write for Complete Information

Ask for Bulletin No. 35

Consult your Classified Directory

PALMER

THERMOMETERS, INC.
Mfrs. of Industrial Laboratory, Recording and Dial Thermometers
Cincinnati 12, O.

What's Happening . . .

dent of the institute which numbers 11 small refiners among its membership.

Present plans are to undertake an advertising campaign in certain selected papers to inform Californians that a healthy and vigorous independent segment of the petroleum industry keeps gasoline prices realistic through fair competition.

Changing Times

Olin Matheson is facing strong opposition from citizens of Niagara Falls, N. Y., where it hopes to build a chemical research laboratory. Escambia Chemical faced similar problem late last year from citizens of Wilton, Conn. Big question is, why are chemical research laboratories so undesirable?

U. S. Army is testing new method of transporting bulk liquids to hard-to-reach areas. **Instead of mounting containers on wheels, it fills the "wheels" themselves** which are collapsible rubber containers. Six such "wheels" pulled by Army track vehicle can move more than 3000 gallons of fuel.

ODM has slammed the door on fast tax write-offs for expansion of alkylate facilities. Only way to reopen it is to present "convincing" evidence that such facilities are essential to national defense.

Joint API-ASME committee on unfired pressure vessels has been discontinued after announcement of intent failed to bring any objections. Move came after decision that engineering profession now agrees with petroleum industry engineers on design and construction of safe pressure vessels for process industry use.

Three chemical firms have finally settled their argument with city of Deer Park, Texas. To keep city from annexing the land upon which Rohm & Hass, Diamond Alkali, and Lubrizol have plants, **firms will pay city total of $40,000 a year until 1965.** Strips of land around plants will be annexed to prevent some other municipality from taking over the area.

Chemical industry and Pentagon traded "pats on the back" when Manufacturing Chemists Assn. presented Army Chemical Corps with commendation certificate for low accident frequency rate in hazardous situations that would not occur in private industry. Then, **Monsanto won Defense Dept. award for outstanding cooperation with reserve program** of armed forces. Monsanto gives military leave plus vacation time, then makes up difference between company and military pay.

Kurt Wallerstein (wealthy research chemist who reportedly controls at least 25 chemical companies) and his **Watford Chemical Co.** have been charged by U. S. district court in New York with **illegally trading chemical materials with Communist China and Poland during Korean conflict.**

Two Oklahoma based oil companies are moving to Texas. Frankfort Oil Co., Bartlesville, will make its headquarters in Dallas while Toklan Oil Corp., Tulsa, will settle in Houston. **Reason:** Firms claim inequitable and stringent oil allowables in Oklahoma.

Esso has prevented another tax hike on its Bayonne, N. J., plant by telling Bayonne city commission that higher taxes would mean either curtailment of operations or closing of plant. **Commission acquiesced to warning** by deciding city could operate on 90 percent of last year's spending.

New Indiana-Standard plan enables employes to continue their education in any accredited school, college, or trade school and **company will pay 75 percent** of tuition, registration, laboratory and other fees. Plan is effective immediately, and is open to any permanent employe.

Phillips Petroleum and Pacific Petroleums refinery will be the **first ever built to operate entirely on natural gasoline as raw material** for gasoline . . . **four processes for isomerization** of pentanes and hexanes to improve octane blends have been announced since early '56, but only one refiner has made specific plans to use one. **Continuing octane race will, however, eventually cause others to follow suit . . . Socony Mobil is offering free Salk vaccine shots** to 2500 employes. Possibility that offer may be extended to other Socony operations . . . **Smog may be one cause of fabrics losing their strength,** and dyes fading. Tests in heavy and light smog areas indicate relationship between density of air pollution, and effect of smog on clothing . . . **U. S. Air Force is testing silicone based transparent rubber** as an interlayer in windshields of high speed aircraft. Rubber is said to keep its strength from —65 to 359 F. . . . Society of Automotive Engineers experts **say fuel injection has great potential, but still faces many obstacles;** gas turbine engines are still far over the horizon; and atomic power plants for passenger cars are out of the question.

Changes In Ownership

El Paso Natural Gas Co. has received temporary approval from Federal Power Commission to buy the McElroy-Wilshire gasoline plant from Lone Star Producing Co. El Paso and Hunt Oil Co. will pay half the cost of acquisition and will jointly construct new gathering lines.

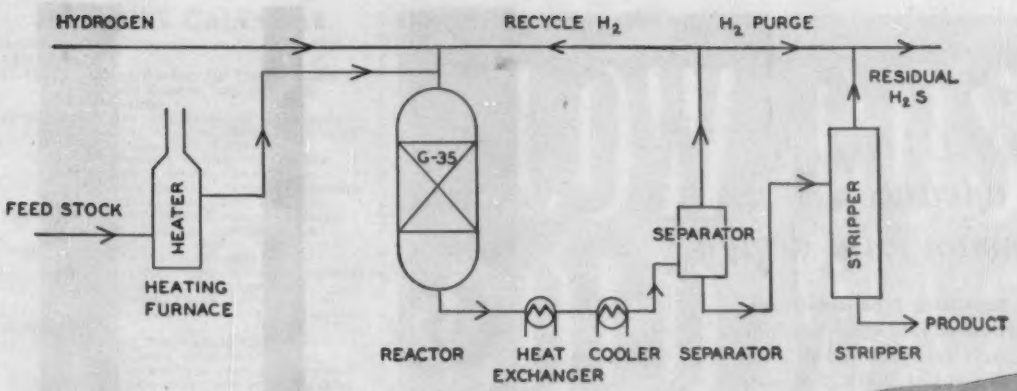
United States Rubber Co. has acquired North British Rubber Co., Ltd., of Edinburgh.

Heyden Chemical Corp. and Newport Industries, Inc., merger (PETROLEUM REFINER, Dec., p. 302) **is now official** as stockholders of both companies have approved the move. Terms of the agreement call for Heyden common stock to be exchanged in the ratio of one and one-half shares for one share of Newport, and the assumption of Newport's liabilities.

Hydrocarbon Chemical Co., Newark, N. J., became the latest chemical firm to buy into the oil industry when it acquired Coffield & Guthrie, Inc., Rockdale, Texas. For the price which hovered over the $3 million mark, Hydrocarbon got over 600 producing wells, and about 80 miles of two to six inch gathering lines.

Dorchester Corp. has acquired the gasoline plant of Texon Gas, Inc. Plant is located in the Big Lake Field in Reagan County, Texas, and has a capacity of approximately six million feet of gas per day. Purchase price was not disclosed.

For more data on advertised products, use Readers' Service Cards, last page.



Naphthas, middle distillates, gas oils and lube stocks can all be upgraded by hydrogen treating with the use of new Girdler G-35 catalysts. These highly active cobalt molybdenum catalysts were developed specifically for the desulfurization, denitrification and stabilization of petroleum feedstocks covering a wide molecular weight range. Typical flow diagram is shown.

Check these outstanding benefits of G-35 hydrogen-treating catalysts

G-35 HAS OUTSTANDING PHYSICAL PROPERTIES — these are retained even after extended use. Permit outstanding operational flexibility, continuous economical operation with essentially 100% yields.

IMPROVEMENT OF COLOR stability, lead susceptibility, burning characteristics and the removal of poisons from catalytic reforming feedstocks are among the more important results achieved. Girdler's expanded production facilities are geared to meet your needs for G-35 catalysts.

DETAILED INFORMATION is available on G-35 catalysts. Bulletin GC 304 discusses applications, gives process conditions for various distillate stocks, performance features and typical catalyst specifications. Free on request.

CATALYST DEPARTMENT

The GIRDLER Company

A DIVISION OF NATIONAL CYLINDER GAS COMPANY
LOUISVILLE 1, KENTUCKY

GIRDLER MANUFACTURES CATALYSTS FOR: HYDROGENATION • SYNTHESIS GASES AND HYDROGEN GENERATION • DESULFURIZATION • NEW CATALYTIC PROCESSES

ANNOUNCING...
a major advance
in expansion joint design

New Zallea Self Equalizing Expansion Joints offer four important advantages. Years of continuous research have resulted in a new Self Equalizing Expansion Joint that lasts longer, is substantially shorter, one-third lighter, and has greater stability.

Longer life. Hundreds of cycling tests to destruction prove that you can expect as much as 100% longer life from the new Zallea Self Equalizing Expansion Joint.

Lighter weight. Weight of the expansion joint has been reduced as much as one-third. Handling and installation are easier.

Shorter length. Over-all length has been reduced as much as 30%.

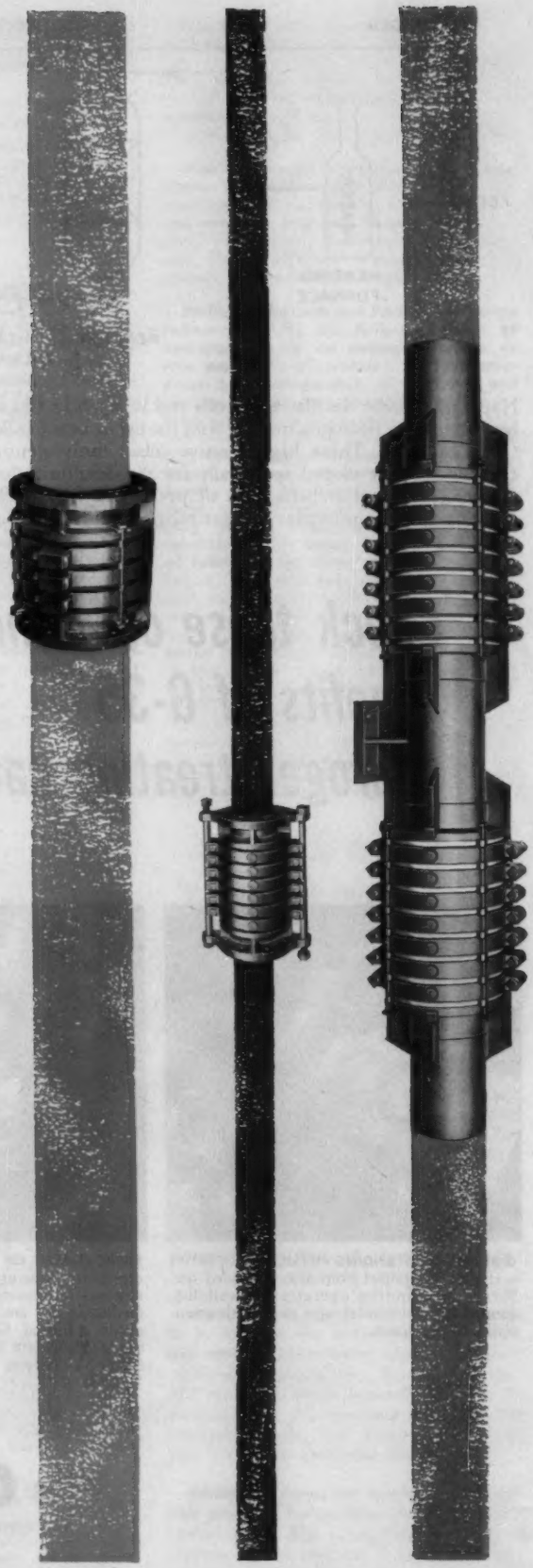
Greater stability. Reduction in ratio of length to diameter means higher stability at high test pressures—no need to support the expansion joint to prevent buckling during test.

Sizes and traverses. Sizes range from 3" diameter to 72" diameter, for traverses up to 7½" in a single unit or 15" in a double unit.

Working pressures. Although normally intended for 150 and 300 psig working pressures, Self Equalizing Expansion Joints can be designed for higher pressures.

Service. The Self Equalizing Expansion Joint is ideal for applications in long lines when there is considerable axial expansion and infrequent movement . . . such as district heating lines which seldom cool down during the heating season.

Get the complete story of the new Zallea Self Equalizing Expansion Joint in our newly published 72-page Zallea Expansion Joint Manual. Write today, on your Company letterhead, for your copy of Catalog 56. Zallea Brothers, 890 Locust Street, Wilmington 99, Delaware.



Zallea
expansion joints

Zallea Brothers, Wilmington 99, Delaware • World's largest manufacturer of expansion joints

MEETINGS CALENDAR

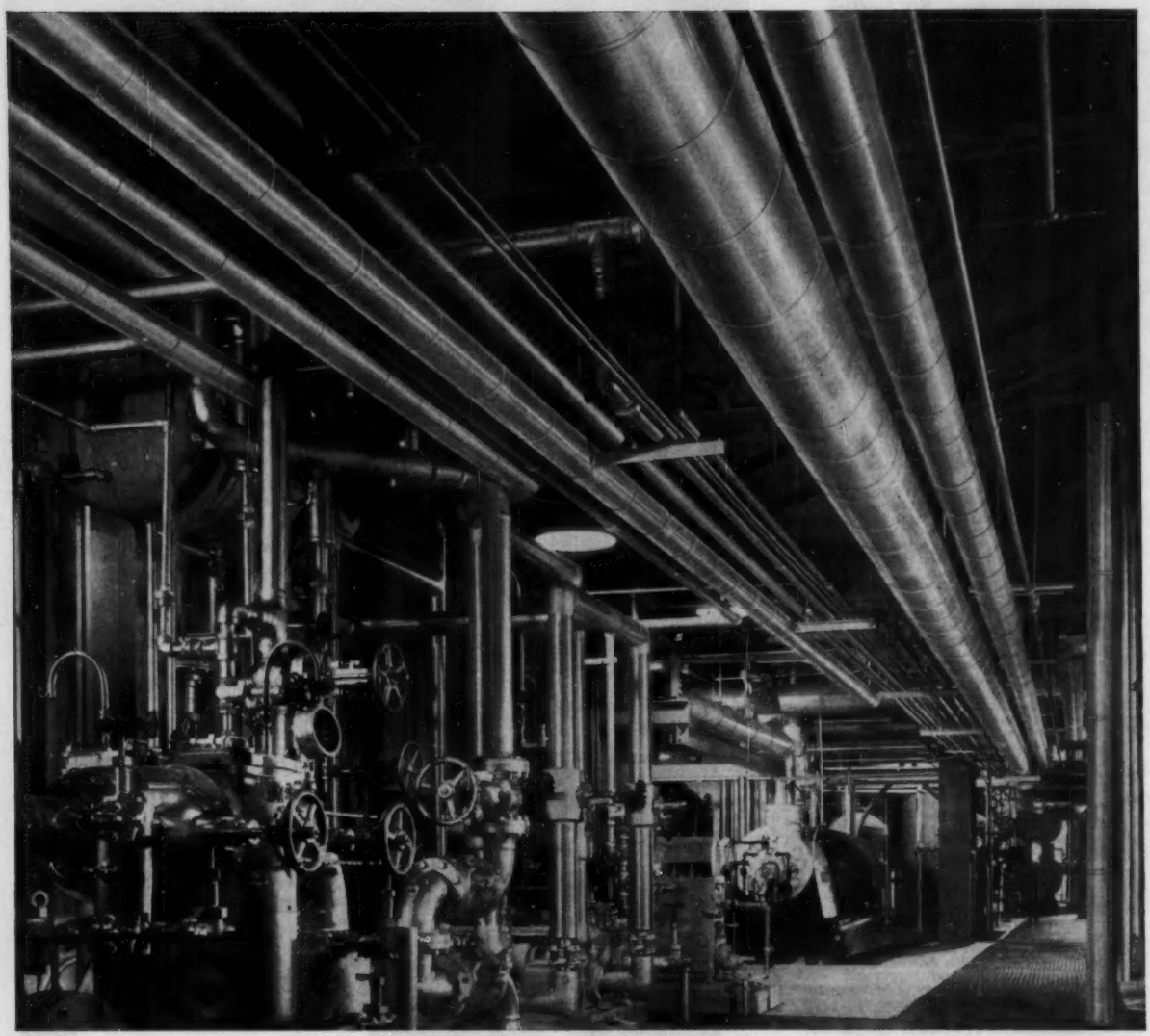
FEB.	
13–15	American Society for Quality Control Study Course, Lamar Hotel, Houston.
14–16	American Association of Cost Engineers, Board of Directors, Winter Meeting, New York City.
16	The American Society for Quality Control, Southwest Section, Conference on Statistical Quality Control, Rice Hotel, Houston.
19–20	Chemical Market Research Association Meeting, New Sheraton Hotel, Philadelphia.
22	Natural Gasoline Association of America, Permian Basin Regional Meeting, Scharbauer Hotel, Midland, Texas.
MAR.	
3– 6	American Institute of Chemical Engineers, Greenbriar Hotel, White Sulphur Springs, Virginia.
4– 8	Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Penn-Sheraton Hotel, Pittsburgh.
10–13	American Institute of Chemical Engineers, Greenbriar Hotel, White Sulphur Springs, Va.
11–15	Chemical Industry Symposium of 13th Annual Conference and Exhibition of the National Association of Corrosion Engineers, Kiel Auditorium, St. Louis.
11–15	Nuclear Congress, Convention Hall, Philadelphia.
18–21	American Society of Mechanical Engineers, Second National Conference of the Gas Turbine Power Division, Sheraton Cadillac Hotel, Detroit.
18–21	Society of Plastics Industry, Annual Conference and Pacific Coast Plastics Exposition, Shrine Exposition Hall, Los Angeles.
25–27	Western Petroleum Refiners Association, 45th Annual Meeting, Hilton Hotel, San Antonio, Texas.
25–29	Tenth Western Metal Exposition and Congress, American Society for Metals and Other Technical Groups. Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles.
27–29	American Power Conference, Annual Meeting, Sponsored by Illinois Institute of Technology, Hotel Sherman, Chicago.
APRIL	
2– 4	Corrosion Control Short Course, University of Oklahoma Extension Study Center, Norman.
7–12	American Chemical Society, 131st Annual Meeting, Miami, site unreported.
8–10	The American Society of Mechanical Engineers, Spring Meeting, Dinkler-Tutwiler Hotel, Birmingham, Ala.
8–12	American Welding Society, Spring Technical, National and Welding Show, Sheraton and Bellevue-Stratford Hotels, Philadelphia.
9	"Catalysis in Practice" Meeting, AIChE Philadelphia-Wilmington Section, University of Pennsylvania Museum, Philadelphia.
16–18	National Petroleum Association, Semi-Annual Meeting, Cleveland Hotel, Cleveland.
24–26	National Gasoline Association of America, 36th Annual Convention, Rice Hotel, Houston.
25–26	The American Society of Mechanical Engineers, Conference on Management, Statler Hotel, New York.
28–30	Independent Petroleum Association of America, Midyear Meeting, Buena Vista Hotel, Biloxi, Miss.
29–May 1	American Oil Chemists' Society Annual Meeting, Roosevelt Hotel, New Orleans.
MAY	
13–14	Commercial Chemical Development Association, Resort Meeting, French Lick, Ind.
13–16	American Petroleum Institute Division of Refining, Midyear Meeting, Sheraton Hotel, Philadelphia.
14–16	Industrial Nuclear Technology Conference, Museum of Sience and Industry, Chicago.
19–23	The American Society for Mechanical Engineers, Oil and Gas Power Conference, Kentucky Hotel, Louisville, Ky.
23–24	Western Petroleum Refiners Association, Southwest Regional Technical-Industrial Relations Meeting, Hotel Paso del Norte, El Paso, Texas.

LOW COST
COLD WATER
(Graham)
Steam Vacuum
Refrigeration
If obtaining low cost cold water is going to be your headache next summer, it will pay you to let us investigate your problem now. Our recommendation costs you nothing.
The installation shown is producing 600 tons of refrigeration at 45° — and is doing it cheaper than by any other known system.
Graham
MANUFACTURING CO., INC.
Offices in principal cities and Canada

For more data on advertised products, use Readers' Service Cards, last page.

Kaiser Aluminum snap jackets give you

A NEW, FASTER WAY TO



Now, with *snap jackets* made with Kaiser Aluminum, one man can install aluminum pipe jacketing quickly and economically.

An outstanding example of recent improvements in aluminum jacketing techniques, the *snap jacket* is a sheet of Kaiser Aluminum, roll-formed into a tubular shape and stiffened along one edge by an angular crimp. Rigid, but sufficiently flexible, the jacket can be quickly snapped into place around insulated pipe by only *one man* and assures a more durable, more weather-tight installation.

Because it is made with Kaiser Aluminum, the *snap jacket* gives you improved appearance and longer life at low cost.

For immediate assistance on any jacketing requirements, call the Kaiser Aluminum sales office listed in your phone directory. Process Industries Department, Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office,* Palmolive Bldg., Chicago 11, Illinois; *Executive Office,* Kaiser Bldg., Oakland 12, California.

INSTALL ALUMINUM JACKETING

1. ONE MAN can quickly position tubular *snap jacket* for installation.

2. NEXT, same man easily snaps *snap jacket* around pipe, places laps properly and bands the jacket to complete the job.

3. TO SAVE even more time, two men can work together . . . one man snaps jackets in place, follow-up man bands them.

For this new, faster way to install aluminum jacketing, Kaiser Aluminum alloy 5005-H16 is recommended. Other alloys may be used depending on the job, but it is desirable to use one alloy throughout.

Recommended thicknesses of sheet aluminum:

For insulation O.D. of 12.75" and under	**0.020"**
For insulation O.D. of 14" and larger	**0.024"**

Kaiser Aluminum

materials for the process industries

For *complete* information about aluminum jacketing with illustrated on-the-job techniques, send for the new 40-page *free* manual "Kaiser Aluminum Insulation Jacketing Materials And Methods."

MAIL THIS COUPON TODAY!

KAISER ALUMINUM & CHEMICAL SALES, INC.,
Process Industries Department, Room 71211
1924 Broadway, Oakland 12, California

Please send my copy of your new manual "Kaiser Aluminum Insulation Jacketing Materials And Methods." I understand there is no obligation.

NAME_____ TITLE_____

COMPANY_____ ADDRESS_____

CITY_____ STATE_____

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening . . .

. . . *Among Men* in the Industry

R. B. Stewart has been promoted to manager of Phillips Petroleum Co.'s natural gas department, he succeeds **A. M. Rippel,** who died Dec. 12 in the crash of a company plane near Bartlesville, Okla.

Stewart

Dan L. Mayer, formerly general superintendent of the department, has been advanced to replace Stewart as assistant manager.

Also announced was appointment of **M. H. Cullender,** previously gas sales representative at Amarillo, Tex., as director of the department's engineering division, which is a consolidation of the former mechanical engineering and production engineering divisions. The former coordination and gas settlements divisions have been consolidated into a services division with **C. T. Dickerson** as director. **W. L. Cox** succeeded Cullender as Amarillo representative.

Jack E. Fulgham has been named plant superintendent of the Stanolind Oil and Gas Co.'s Three Bar gasoline plant. Fulgham joined Stanolind in 1947 as an operating engineer in South Jennings, La. Since that time, in addition to service in the general office in Tulsa, he has served as plant engineer and plant foreman at the Slaughter gasoline plant, and as plant foreman at the North Cowden and South Fullerton gasoline plants.

Fulgham received a B.S. degree in Chemical Engineering from Texas A. & M. College in 1931.

William J. Abnett has been appointed assistant project engineer in Sun Oil Co's. Manufacturing department. He previously served as assistant technical adviser on natural gas and natural gasoline projects in Sun's Production department.

Abnett's new duties will concern plant construction supervision. Additionally, he will specialize in boiler installations, steam and power systems, circulating water systems and installation of cooling water towers.

Abnett graduated from the University of Wisconsin in 1948 with a B.S. degree in mechanical engineering, and joined Sun in May, 1949.

C. C. Whittelsey has been elected president of Ford, Bacon & Davis, Inc., engineers-constructors, and its wholly-owned subsidiaries, Ford, Bacon & Davis Construction Corp. and Ford, Bacon & Davis Canada Ltd. He succeeds **E. S. Coldwell,** who will actively continue as chairman of the board of directors. Whittelsey was formerly executive vice president.

C. E. Evans has been appointed general manager of British Hydrocarbon Chemicals, Ltd. He joined British Hydrocarbons in October 1951, being appointed manager at the Grangemouth plant in Scotland. He was appointed general manager, Grangemouth, in 1954.

Evans joined The British Petroleum Co., in 1939 and served in Iran in a variety of appointments, culminating as works manager of Abadan Refinery.

Also, **D. Blair Watt** has been appointed works general manager at Grangemouth. Watt has been with The British Petroleum Co. for 19 years.

Les Gibbs has been sent from the Bayway refinery to a two-year assignment with Esso Standard Oil of France where he will aid in setting up the first butyl rubber plant near Paris.

Sullender

Anderson

William A. Sullender has been named to the newly-created position of assistant manager of operations in the marketing department of American Oil Co.

Sullender, who was transferred from the company's Texas City, refinery where he has served as assistant general superintendent of operations and utilities since 1953, will make his headquarters in New York.

The company also announced the promotion of **Reader G. Anderson** to fill the position previously held by Sullender at Texas City. Anderson, who has been on six months temporary assignment as assistant to the general manager of manufacturing in New York, will return to Texas City to take up his new duties.

Anderson joined the company at Texas City in 1942 as a chemical engineer in the research and development department. Six years later he was named assistant head of the light oil department and in 1950 he was appointed to a similar position in the catalytic and distillation department. In 1952, he was promoted to department supervisor of coordination and economics and in 1953 was elevated to operating superintendent.

Stanley W. G. Lehman and **James V. Pickering** have been elected to the board of Standard-Vacuum Oil Co., in White Plains, New York. Membership on the Stanvac board has thus been increased from eight to ten.

William J. Rosenbloom has been appointed director of engineering for the Chemical Construction Corp., a subsidiary of Electric Bond and Share Co. He developed the electrolytic hydrogen cell and the atmospheric ammonium sulphate process used in many of the plants designed and engineered by Chemico.

Rosenbloom

Rosenbloom joined Chemico in 1937, and from 1952 to 1955 served as chief engineer of Chemical Construction (I.A.) Ltd., in Toronto. He has been engaged in the design and start-up of plants in China, India, Cuba, Phillippine Islands, Canada and the United States.

Rosenbloom is a graduate of McGill University with a B.S. degree in chemical engineering.

Donald R. Skahan has been appointed director of creative activities, and **Floyd F. Ackerman** has been assigned the duties of advertising supervisor of the American Petroleum Institute's Oil Information Committee. It was also announced that **Peter T. Mulhare** will join the API staff as production supervisor.

Skahan has been on the API staff since 1951 as production supervisor. In his new position he will supervise and coordinate all activities relating to editorial production, research, publicity, advertising, and the film program.

Ackerman joined the API in 1953 as supervisor of the employee information program, and a year ago also assumed the responsibilities of the film program. Mulhare comes to the API staff from the Italian Line, where he was assistant advertising manager.

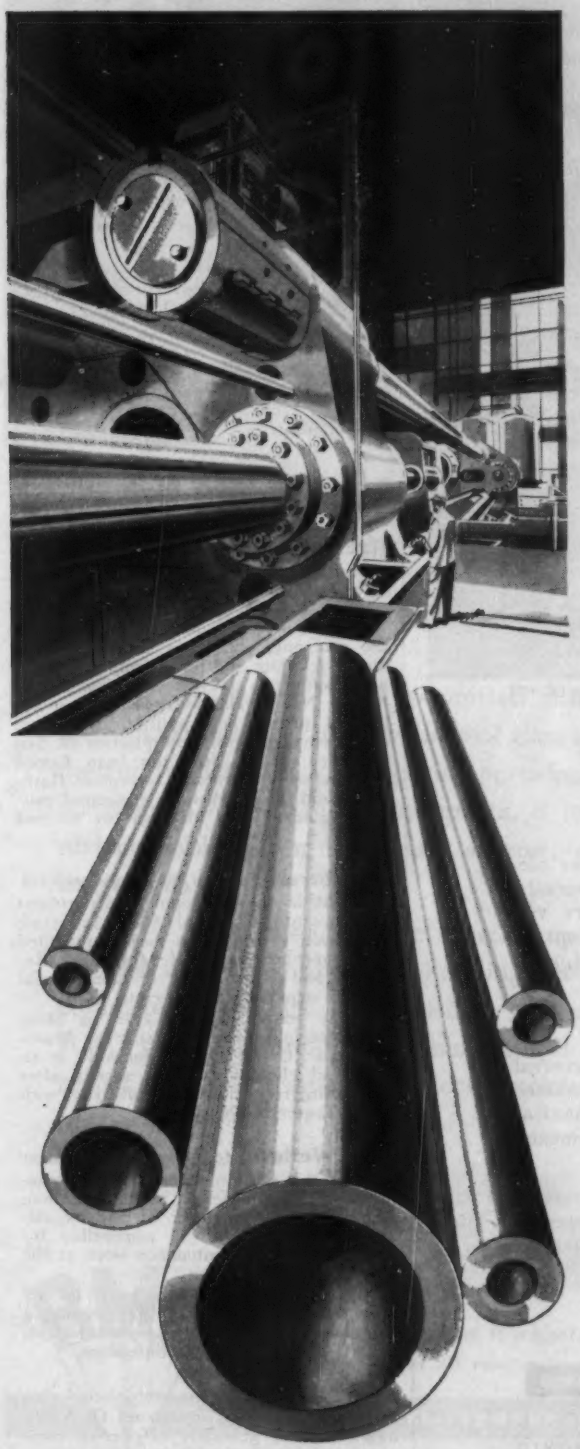
Reid Brazell, president of Leonard Refineries, Inc., has been requested by U. S. Secretary of the Interior Fred A. Seaton to again serve on the National Petroleum Council.

In requesting Brazell's service on the Council, Secretary Seaton cited the value to government of industry providing advice and counsel on matters pertaining to petroleum and natural gas.

Arthur B. Tillman, assistant works manager, operations, of the Painesville, Ohio plant of Diamond Alkali Co., Cleveland, has been promoted to the newly-created position of Electro Chemicals division operations manager.

At his new post, Tillman, a veteran of more than 20 years' experience with the company, will hold responsibility for operations at Diamond electrolytic chlorine-caustic soda plants. He will take over his new duties in May following attendance

NOW! from the world's largest horizontal steel extrusion press...



SEAMLESS

HEAVY WALL PIPE

from any ferrous alloy

Now heavy wall pipe can be extruded from any ferrous alloy – in lengths up to 50 feet or more, with O.D.'s from 4″ to 22″, and with virtually no restriction on wall thickness.

The giant Curtiss-Wright horizontal extrusion press, now operating at the Metals Processing Division, *moves* the metal instead of *removing* it, for pipe of maximum length – and strength.

If your application calls for higher heat, corrosion and/or abrasion resistance – in pipe of highest tensile and yield strengths – Metals Processing Division is geared to fill the requirement. Complete facilities for handling any ferrous alloy, including the stainless series, as well as titanium and other reactive metals, are available to the chemical, petroleum, power and other key industries.

Take advantage of this new, aggressive facility for your pipe requirements. Write, wire or telephone for detailed information or engineering consultation today. Our field engineers are at your service.

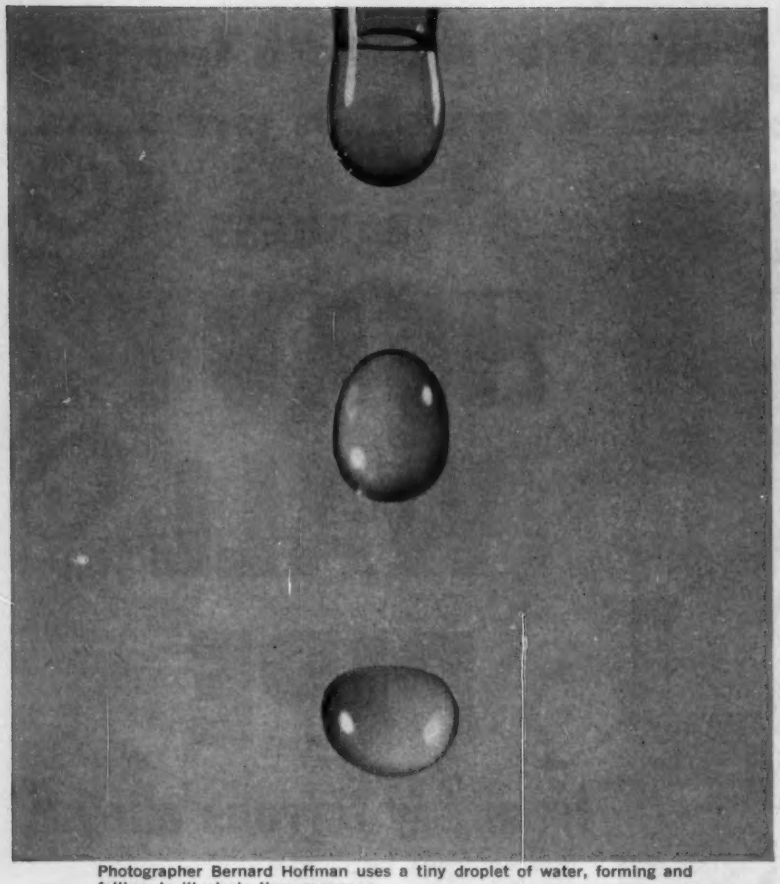
70 GRIDER STREET

METALS PROCESSING DIVISION

CURTISS-WRIGHT

CORPORATION • BUFFALO, NEW YORK

For more data on advertised products, use Readers' Service Cards, last page.



Photographer Bernard Hoffman uses a tiny droplet of water, forming and falling, to illustrate time sequence.

Controlling Time in Fluid Engineering

Even in simple hydrodynamic situations like the one pictured above, time sequence is measured in micro-seconds. More often than not, other factors—such as pressure, volume and flow—all tend to complicate fluid time control. That's where the engineering leadership of S. Morgan Smith can help you most.

SMS Rotovalves, for example, will give you the closest control of closing time . . . as quick as one second or as slow as needed. Their fast initial shut-off limits reversal of flow, and closure is positive and drop-tight. Rotovalves are easier to operate, requiring less power for mechanical or electrical operation, and their full line opening means less head loss and lower pumping costs.

SMS offers you a complete line of standard Rotovalves, Ball Valves and R-S Butterfly Valves, as well as special application engineering help. To obtain full information, call our nearest representative, or write S. Morgan Smith Company, York, Penna.

S. MORGAN SMITH HYDRODYNAMICS

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

Men in the Industry . . .

at the spring session of Harvard University's advanced management course.

Tillman earned his B.S. and M.S. degrees in chemical engineering from Washington University. He joined the Diamond organization as a chemical engineer in 1935, coming from the Band-Box Corp. former Diamond affiliate.

John F. Gardner has been elected vice president in charge of employee, public relations and advertising of The Fluor Corp., Ltd.

Gardner

Gardner, who formerly served as director of employee, public relations and advertising, has been with Fluor for the past 16 years. He has held previous positions as manager of project coordination and administrator of foreign subsidiaries for the company.

Gardner attended the University of Southern California.

H. E. Bramston-Cook has been elected a member of the board of directors of Oronite Chemical Co., chemical subsidiary of Standard Oil Co. of California.

Bramston-Cook, now vice president of the company, will be responsible for industry relations and for coordinating company policies in the eastern United States.

Also **N. E. Hathaway** has been appointed to the new position of general sales manager, with headquarters in San Francisco; **J. R. Stitt** has been named coordinator of marketing to replace Hathaway, and **T. M. Welton**, appointed eastern regional sales manager to succeed Stitt.

K. Warren Easley, St. Louis, project specialist in the development department of Monsanto Chemical Co.'s Inorganic Chemicals division has been appointed development manager of Monsanto's Research and Engineering division special projects department at Everett, Mass.

Easley served for two years as Monsanto's technical representative at Washington, D. C. He joined Monsanto as an analytical chemist in 1945 shortly after graduating from Purdue University with a B.S. degree in chemistry.

C. L. Wallace, formerly superintendent of The Ohio Oil Co.'s Lovell, Wyo., refinery, has been transferred to the Robinson, Ill., refinery. A member of the maintenance staff, he will be responsible for coordinating all maintenance work at the refinery.

An employe of the company for 27 years, Wallace has been a gangpusher, a stillman, assistant refinery superintendent, as well as a refinery superintendent.

John M. Houchin has been elected vice president of Phillips Petroleum Co., with duties relating generally to over-all company activities but with primary responsibilities relating to the production and foreign departments. **Harry G. Fair** suc-

NO FOG *with Rochester*

Hermetically Sealed Dial Instruments

Moisture, when permitted inside an instrument dial, not only fogs the dial glass but has destructive access to vital working parts inside. In addition to hard-to-read instruments, it leads to undependable performance and shorter, costlier instrument life.

Rochester Manufacturing Company developed its own hermetic dial-sealing process to completely eliminate this moisture hazard. The RMC process insures that humid air will not be sealed in the instrument and locks moisture out *permanently*.

Look to RMC for Full-Line Instrumentation

LEVEL GAUGES

Illustrated is an 8" dial, float-operated level gauge, with magnetically driven pointer, for pressure vessels. What is your liquid level gauge problem?

PRESSURE GAUGES

Illustrated is a heavy-duty compound type gauge for service on high frequency, low amplitude vibration. What is your pressure or vacuum gauge problem?

TELL US YOUR REQUIREMENTS FOR DIRECT MOUNTING AND REMOTE INDICATING INSTRUMENTS, AND LET RMC ENGINEERING SKILL PROVIDE THE ANSWERS!

Write today, outlining your particular need or problem.

RMC

"You Can Rely On Rochester"

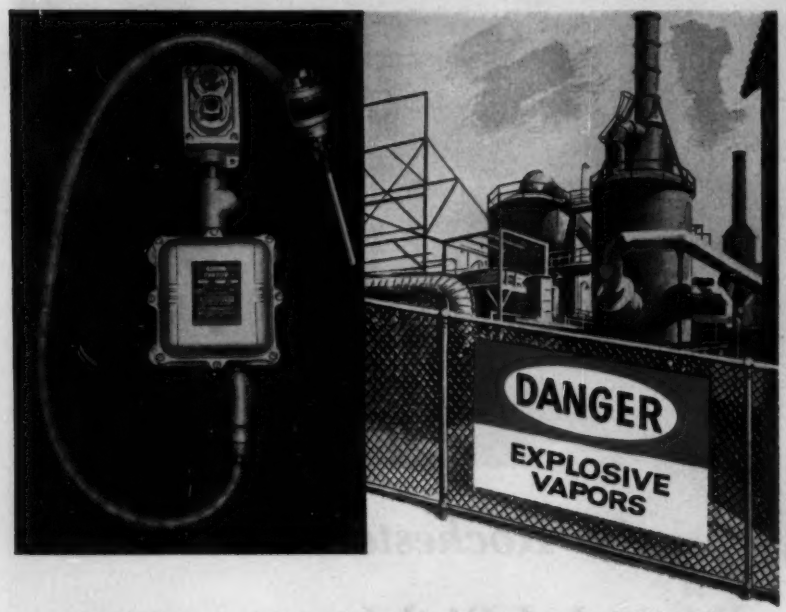
REPRESENTATIVES IN ALL PRINCIPAL CITIES

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

ROCHESTER MANUFACTURING CO., INC.

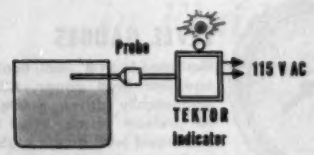
38 ROCKWOOD STREET • ROCHESTER 10, N.Y.

TEKTOR® Electronic Level Control safe for hazardous locations



Practically every plant can improve level control electronically—and meet safety requirements—now that the entire Fielden TEKTOR System is UL listed and FM approved for Class I, Groups C and D, and Class II, Groups E, F and G, hazardous locations.

This explosion-proof unit features a specially-designed ferralloy housing and Teflon* insulated probe. Available for fail-safe high or low level control, it features the same simple and versatile capacitance circuitry found in the standard TEKTOR unit.



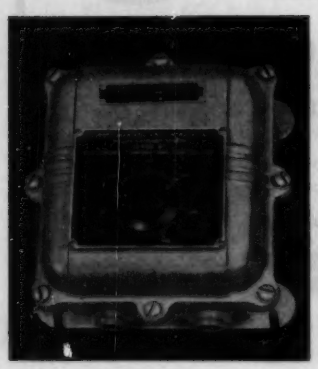
As level changes, capacitance at the probe also changes and energizes a relay. TEKTOR flashes a warning and can operate controls to keep level from exceeding desired limit.

*Trade-mark for Du Pont tetrafluoroethylene resin.

TEKTOR features

- Controls level of liquids, liquid interface, powders, granular solids (conducting or non-conducting)
- Responds to changes as small as 1/16" in aqueous solutions
- No moving parts—only one radio tube

NEW EXPLOSION-PROOF TEMPERATURE CONTROLLER



Fielden's sensitive Series 97 Controller is now available in explosion-proof design for hazardous locations. Used with resistance temperature detectors, this controller actuates two-position control devices with changes as small as ±0.2° F. Ranges from —330° F. to +1382° F. Lamps show whether temperature is above or below control point setting.

Write for literature

Robertshaw-Fulton CONTROLS COMPANY

FIELDEN INSTRUMENT DIVISION

Dept. A, 2920 N. 4th St., Philadelphia 33, Pa.

Men in the Industry...

ceeds Houchin as chairman of the operating committee, and **W. C. Hewitt** succeeds Fair as vice chairman of this committee. **Harry D. Brookby** becomes manager of the foreign department, headquartered in Bartlesville, Okla.

Houchin started with Phillips at Oklahoma City in 1933 and worked in engineering capacities in several areas of the production department. He later served as assistant superintendent in two of the production department's districts and as district superintendent in western Kansas. He was named assistant general superintendent of the production department in 1944 until 1951 when he became general superintendent. He was made chairman of the company's operating committee in February 1956.

Dr. B. D. Thomas has been named Battelle Institute's new director. In this position, he succeeds Dr. Williams in the management of Battelle's research operations in the United States and Europe.

A member of the Institute's executive and technical staff since 1934, Dr. Thomas was appointed assistant director in 1942. Subsequently, he was named secretary of the Battelle Memorial Institute Corp. and in July, 1955, he became vice president.

Dr. Thomas' varied scientific interests are reflected in his report on "The Technology of Iron Ore" for the President's Materials Policy Commission, his published papers on the chemistry of sea water, and his papers on methods of separating, sorting, and concentrating of minerals.

Fred H. Ramseur, Jr., Shreveport, La., has joined New York headquarters of Cities Service Co. as coordinator of light ends and natural gasoline plants.

Ramseur for several years has been manager of the natural gasolene division of Arkansas Fuel Oil Corp. Previously, he had served in several engineering capacities with that company and associated companies, subsidiaries of Cities Service. He graduated from North Carolina State University with a B.S. degree in chemical engineering.

E. L. Tandrup has been appointed a technical representative of Ethyl Corp.'s Detroit Research Laboratories.

Tandrup, who has been associated with Ethyl since 1939, will act in a liaison capacity between the Ethyl Research Laboratories and Ethyl customers in West Virginia and the western section of New York and Pennsylvania. A native of Chicago, Tandrup received a B.S. degree in mechanical engineering from the University of Illinois in 1939.

Elmer O. Mattocks has been appointed director of the department of technical services of the American Petroleum Institute. Mattocks, who has been assistant di-

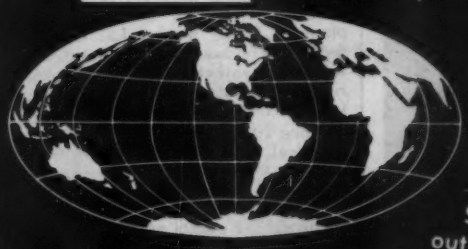
For more data on advertised products, use Readers' Service Cards, last page.

safety is paramount

– in every country

– in every currency

– in every language



SAFETY has about the same connotation throughout the Petroleum Industry of the World—whether it be in the steaming jungles of Indonesia, the burning sands of the Middle East, or on the endless plains of TEXAS.

Life is dear to every man, whether he be a laborer or a man of high estate. His SAFETY is of deep concern, not only to himself, but to those dependent upon him—his family and his employer.

Petroleum equipment like petroleum itself is very valuable, and the more inaccessible and distant its location, the higher its cost becomes. Wherever it is, it is worth PROTECTING and the entire Petroleum Industry is alert to providing the necessary safeguards.

For nearly Forty Years, SHAND & JURS COMPANY has been a leading supplier of SAFETY and CONSERVATION EQUIPMENT to the Petroleum Industry of the World, and to make it available to all who need it, identical equipment is made both in the United States and in Great Britain, so if you deal in Dollars or in Pounds you may avail yourself of the Worlds Best in TANK SAFETY, CONSERVATION and ACCESSORY EQUIPMENT.

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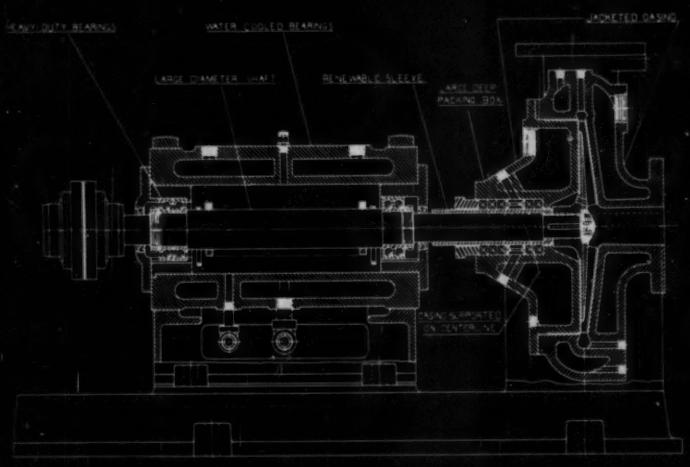
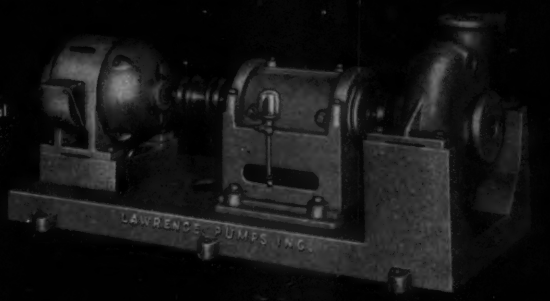
MEXICO, D.F.: Dalmo Comercial, S. A.
CARACAS: Sinclair Spence, C.A., Edificio Galipan
ENGLAND: Whessoe, Ltd., Sales: 25 Victoria St., London S. W. 1
Whessoe, Ltd., Works: Darlington, County Durham

For more data on advertised products, use Readers' Service Cards, last page.

Cross section of Lawrence Horizontal Jacketed Pump



Lawrence Steam Jacketed Chemical Pump with Water Cooled Bearings



HORIZONTAL

jacketed PUMPS

Lawrence jacketed pumps are designed to pump liquids such as sulphur, phthalic anhydride, resins, waxes, etc., which tend to solidify or become viscous at low temperatures. The heating medium can be steam, dowtherm, etc., and all heating spaces are vented and self-draining.

The bearings are heavy-duty, water-cooled. Misalignment and distortion, which might be caused by thermal expansion, are eliminated by supporting the casing along the center line of the shaft.

If you have to pump liquids which must be held above a specified temperature to retain their fluidity, write us the pertinent details. No obligation.

Write for Bulletin 203-7.

LAWRENCE PUMPS INC.
371 Market Street, Lawrence, Mass.

Men in the Industry . . .

rector for the past several years, succeeds **David V. Stroop**, who now will devote all of his time to his duties as executive assistant to the president.

Mattocks joined the Institute staff in 1950, coming to API from Phillips Petroleum Co., Bartlesville, Okla., with whom he had been a technical representative. He is a graduate of Cornell University.

Berndt K. Lyckberg has been appointed general manager of W. R. Grace & Co.'s new high density polyethylene plant in Baton Rouge, La. Lyckberg has been closely associated with the manufacturing of synthetic polymers related to oil refining operations and the plastics industry over the past 17 years.

Since 1951, he has been manager of the chemical laboratories of Firestone Plastics Co. in Pottstown, Pa. During the war he assisted Firestone Tire and Rubber Co. in the start-up and operations of three synthetic rubber plants at Akron, Ohio; Lake Charles, La.; and at Port Neches, Texas, where he became technical manager.

Prior to joining Firestone, Lyckberg was a chemical process engineer with Standard Oil Co. (Indiana) at Whiting, Ind., and Sugar Creek, Mo.

Henry E. Wenger has resigned as chairman of the board of Aurora Gasoline Co. **Max M. Fisher** has succeeded him.

Wenger will remain active on the board of the company, will continue as chairman of the executive committee, and will serve as secretary of the company.

Fisher moves up from his former position as executive vice president and secretary.

William E. Slaughter continues as president, the post he has held since incorporation of Aurora in 1932, and all other officers remain the same.

B. J. Schulz, chief process engineer at Magnolia Petroleum Co.'s refinery in Beaumont, Texas, has been transferred to the headquarters staff of the Socony Mobil Oil Co., Inc., laboratories in New York to assume the position of coordinator of lubricants and allied products.

R. E. Woodham, formerly assistant chief process engineer, has been promoted to chief process engineer at the refinery. **A. B. Hiser**, former supervisory process engineer has taken over Woodham's duties as assistant chief process engineer, and **R. G. Hutton** succeeds Hiser as a supervisory process engineer.

George F. Hornaday has been named associate manager of research and development and **D. Eugene Norris** as assistant process sales manager of Houdry Process Corp.

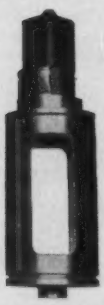
Hornaday moves to the post made vacant at the Research and Development Laboratories in Linwood, Pa., when **T. A. Burtis** was elected president and chairman of the board. Norris succeeds Hornaday in the Philadelphia offices.

Hornaday received his B.S. degree in chemical engineering at Purdue University. He joined Houdry Process Corp. in 1940 as assistant manager of development, and was a member of the planning group that developed and placed on stream the

Multiple Port, 100% Pipe Area or Venturi

Diamond Port or "V" Port for Throttling

Round Port 100% Pipe Area



Rectangular Port 100% Pipe Area

Rectangular Port Venturi

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ALL TYPES OF PORT OPENINGS

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Homestead Lubricated Plug Valve High Pressure Chemical Seal

Name the type of valve you need in the metal or alloy you require with the port opening you want—and we can furnish it. Or if you have a valve problem that defies solution, write us, naming the fluid, concentration, temperature, pressure, valve size, function and frequency of operation. We will be happy to recommend the best and most economical valve for your service conditions.

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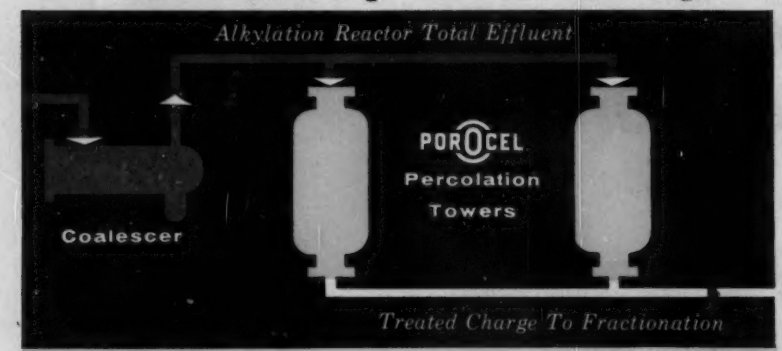
P.O. Box 45 *"Serving Since 1892"* Coraopolis, Pa.

MIN-CHEMISTRY *at work*

case: Alkylation throughput increased, maintenance cut, with Porocel percolation step



The flow sketch shows where sorptive treatment (technique developed by DX-Sunray Oil Co., and M. W. Kellogg Co.) takes place in DX-Sunray's Tulsa Alkylation Unit.

EQUIPMENT REPORT: Simple 2-tower system handles total H_2SO_4 reactor effluent—one on stream while Porocel in the other undergoes unique in-place regeneration.

POROCEL ADSORBENT REPORT:

a. Removes more than 99% of acid and esters (caustic and water wash systems remove about 65%).
b. Virtually does away with corrosion and fouling in fractionating section.
c. Protects against maintenance troubles . . . permits pushing unit to higher capacity.
d. High cycle life . . . long cumulative life (over 150 bbls/lb.).
e. Improved TEL susceptibility; reduced H_2SO_4 consumption; no corrosion inhibitors needed in recovery section.

Our business is to supply low-cost nature-given minerals that are *process-engineered* to make things go smooth in your plant . . . good in your markets. Use the coupon.

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Leaders in creative use of non-metallic minerals
ATTAPULGITE (*Attapulgus*)
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KAOLIN (*Edgar • ASPs*)
LIMESTONE (*Chemstone*)
SPEEDI-DRI FLOOR ABSORBENTS

Men in the Industry . . .

first Houdry Dehydrogenation unit to make butadiene from butane in World War II. After working on development of the Houdriflow moving-bed catalytic cracking process, Hornaday joined the Commercial Development department in 1952 and was appointed assistant manager of process sales early this year.

Norris is a graduate of the University of Pittsburgh in chemical engineering. With Socony-Vacuum, he gained moving-bed catalytic cracker experience on units started up during World War II. He holds several patents in the refining field.

Carl A. Vill has been appointed assistant to the vice president of Chemical Construction Corp., a subsidiary of Electric Bond and Share Co.

Vill

Other posts held by Vill, since joining Chemico in 1934, have been director of engineering and project manager on numerous chemical and petrochemical plants.

Prior to joining Chemico, Vill was engaged in the design of ammonia and nitric acid plants with the Nitrogen Engineering Corp, which was absorbed by Chemical Construction Corp.

Vill is a graduate of Cooper Union with a B.S. degree in civil engineering and is a professional engineer licensed in New York and New Jersey.

Wyman L. Taylor has been made administrative assistant to the vice president, Pacific Coast, of Stauffer Chemical Co. Taylor, a graduate of the University of California, joined Stauffer in 1946. He had been northern California sales manager, Industrial Chemicals, prior to his promotion.

William H. Oliver has been named northern California sales manager replacing Taylor. Oliver has been with Stauffer for 16 years.

For further information please call or write W. Alec Jordan, 270 Park Ave., New York City 17 (PLaza 5-9345) or Public Relations Department, John Mather Lupton Company, Inc., 420 Lexington Ave., New York City 17 (MUrray Hill 9-0950).

W. Earl Dunn has been appointed vice president—general manager of Blaw-Knox Co.'s. Chemical Plants division.

Dunn comes to Blaw-Knox from J. F. Pritchard & Co., Kansas City, where he was vice president and manager of the company's Petroleum division. His experience also includes 20 years with The Fluor Corp., Ltd., Los Angeles. He is a registered professional engineer.

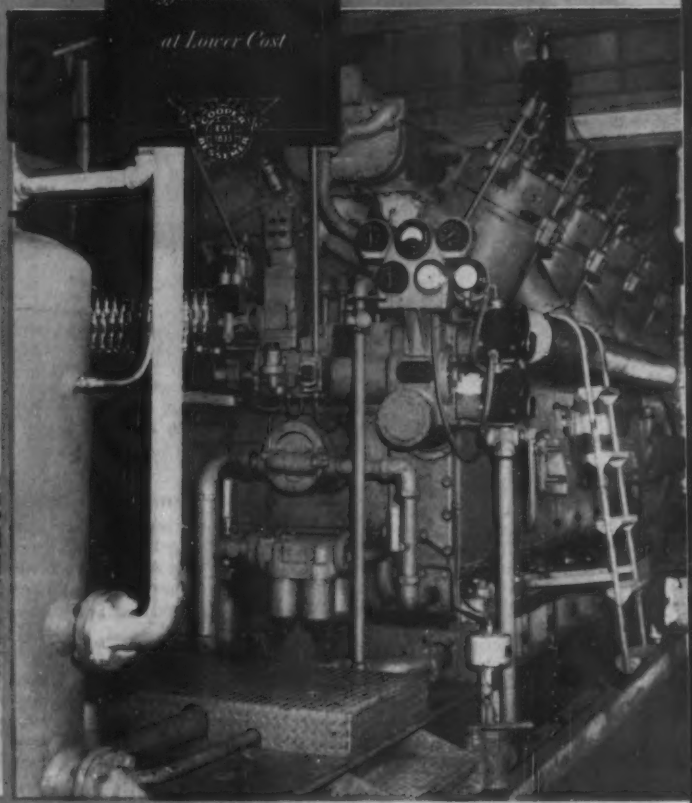
Dr. F. E. James has been promoted to group leader in the Economics section of the Research and Development department of the American Oil Co.

Dr. James joined American Oil Co. in 1953 and in his new position will be primarily responsible for economic studies

Another Example of Efficient Power at Lower Cost

One of three packaged GMXA's in the Eunice, New Mexico, station of United Carbon. These units, rated 550 hp at 450 rpm, efficiently compress a sour casinghead gas.

This view of the Eunice Station shows one of the 8-cylinder Cooper-Bessemers in place, while construction continues on the framework of the compressor building.



How UNITED CARBON sets a new LOW in compressor station costs with PACKAGED COOPER-BESSEMERS

Here are details on "big savings" in United Carbon Company's Eunice, New Mexico, natural gas plant. Three Cooper-Bessemer GMXA compressors, completely packaged, provide exceptional installation economies due to pre-assembly of the following:

1. The entire cooling system.
2. The entire lube oil system.
3. The entire fuel system.
4. The entire starting air system.
5. Entire gas piping to point of inlet and outlet.
6. Elimination of costly piping and design work usually necessary in this type of installation.
7. A simple, inexpensive mat type foundation to accommodate the skid-mounted GMXA compressor.

. . . . seven good reasons that help explain why the Eunice Station *cost less to build* than any of United Carbon's previous compressor installations.

If you have been searching for ways to cut costs . . . . yet maintain compressor dependability, availability, flexibility . . . you'll want to learn more about the latest advancements now being offered by one of the nation's oldest engine and compressor builders . . . Cooper-Bessemer. Contact the nearest office listed below for complete information.

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GROVE CITY, PENNA.

New York City • Seattle, Wash. • Chicago, Ill. • Houston, Dallas, Greggton, Pampa and Odessa, Texas • Washington, D. C. Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. • Gloucester, Mass. • New Orleans, La. • Tulsa, Okla. Caracas, Venezuela • COOPER-BESSEMER OF CANADA, LTD., Edmonton and Calgary, Alberta, Canada.

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS

Men in the Industry . . .

of new and improved chemical processes. He will also share the responsibility for short-range economics in both the chemicals and petroleum areas.

He is a graduate of Carnegie Institute of Technology where he received a B. S. degree in chemical engineering in 1948, a M.S. degree in chemical engineering at Kansas State College in 1950, and a D.Sc. in chemical engineering from Washington University, St. Louis, in 1953.

William M. Holaday, formerly head of the research and development activities of Socony Mobil Oil Co., Inc., has left that company to become deputy assistant secretary of defense (Research and Development). Holaday has been on leave of absence from the company since Feb. 1, 1956, serving in that capacity, with headquarters in Washington, D. C.

Frank Sparks has joined the firm of C. L. (Dutch) Shultz and Associates. Sparks started with Shell Oil Co. in 1929 at Wood River, Ill., then was moved to the Houston refinery in 1932. During his 14 years with Shell he had experience as process plant operator, equipment engineer, and process engineer. Since 1945 he has been active in sales and promotion work of automatic controls and other equipment for refineries and chemical plants.

Schultz opened his office as a consultant in instrumentation for the process industry in May, 1956.

E. Warren Bowden has been elected executive vice president of Walter Kidde Constructors, Inc. He was formerly vice president of the engineering and building firm. He will continue to be a director of Walter Kidde Constructors, Inc., and vice president and director of Walter Kidde Engineers-Southwest, Inc.

Bowden

Bowden joined Walter Kidde Constructors, Inc., in 1943 as assistant to the president. He was previously associate engineer for Parsons, Klapp, Brinckerhoff and Douglas, New York. For a number of years he was assistant to the chief engineer of the Port of New York Authority.

A graduate of Lehigh University, Bowden is a member of the American Society of Civil Engineers.

James N. Hinyard has been appointed director of market development for American Potash & Chemical Corp. He replaces **Dr. A. J. Dirksen** who recently was named general sales manager of the company's Industrial Chemicals division

Hinyard, who holds B.S. and M.S. degreees in chemical engineering from the University of Texas, was with Merck & Co., Inc., at Rahway, N. J., where he was responsible for market research and development of new and existing products.

Henry C. Oliver has been appointed a group leader in the Standard Oil Co. (Indiana) technical service department at Whiting, Ind.

Oliver, who joined the company five years ago, will work in the refinery economics division with particular emphasis on crude oil evaluation and naphtha reforming problems. He is a native of Gary, Ind., and a graduate of Purdue University.

Fred H. Ramseur, Jr., Shreveport, La., has joined Cities Service Company as coordinator of light ends and natural gasoline plants.

Ramseur for several years has been manager of the natural gasoline division of Arkansas Fuel Oil Corp. Previously, he had served in several engineering capacities with that company and associated companies, subsidiaries of Cities Service.

R. R. Dean, formerly vice president, was designated senior vice president in charge of manufacturing and marketing for Tennessee Gas Transmission Co. Also, **Wilton E. Scott,** exploration manager, was elected vice president.

Dean is a veteran in the field of operating natural gas processing plants and marketing LPG. He is president of Bay Petroleum Corp., wholly-owned subsidiary of Tennessee Gas, which refines oil and markets refined products.

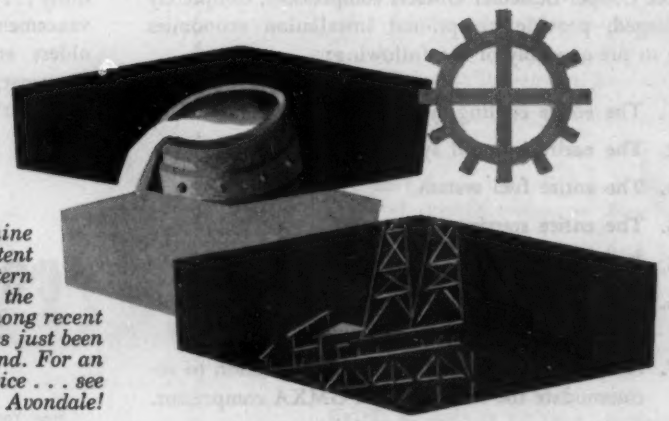
Scott has been a key figure in the expanding oil and gas exploration activities of Tennessee Gas for the past two years. He has 20 years' experience in that field.

a better Foundry service for you . . .

SERVICE FOUNDRY

A DIVISION OF AVONDALE MARINE WAYS, INC.

Foundries have come a long way since the forge and bellows . . . today they are mechanized and specialized, offering a wide variety of products and services including engineering and design. This is certainly true of SERVICE FOUNDRY, a division of Avondale Marine Ways, Inc. In addition to a complete foundry and machine shop service, there is a large and competent staff of engineers, draftsmen, and pattern makers highly skilled in meeting the requirements of your industry. Among recent improvements, a new electric furnace has just been installed—the most modern of its kind. For an all-around better *foundry service . . . see Avondale!*



SERVICE FOUNDRY a division of Avondale Marine Ways, Inc.

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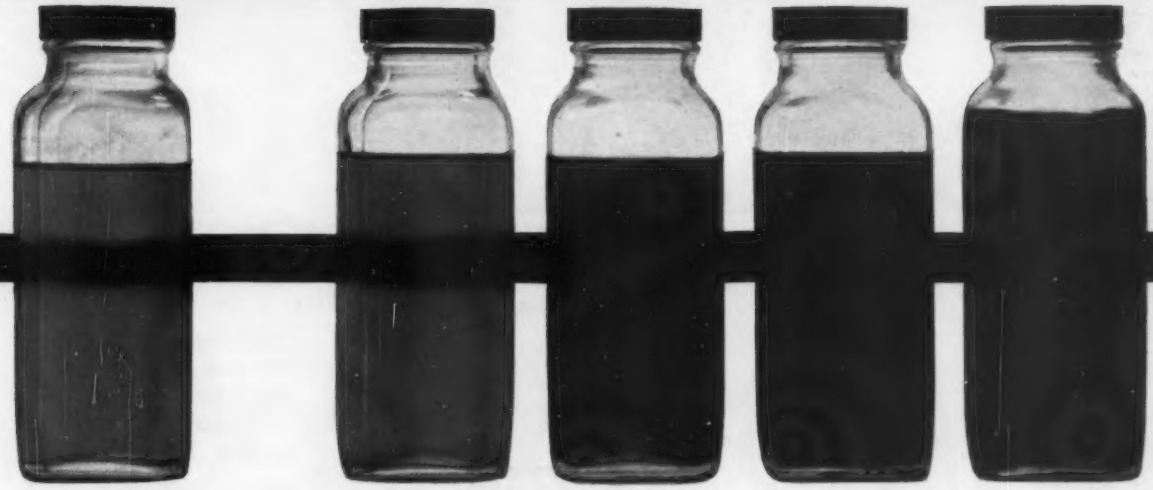
Straight-Run Quality

FOR CRACKED FUEL OILS



DIRECT FROM REFINERY STREAM FRESH FUEL OIL

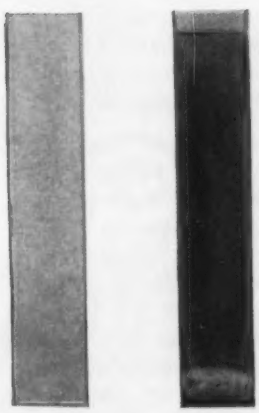
FUELGUARD PROTECTED AGED FUEL OIL

ADDITIVE A TREATED AGED FUEL OIL

ADDITIVE B TREATED AGED FUEL OIL

NO ADDITIVE AGED FUEL OIL

Test results with 50-50 blend of cracked and straight-run fuel oil. Bottle at left contains a blend of oils taken from the refinery streams. The four bottles, at right, contain the same oil blend, which was treated as indicated, and then aged six weeks at 120° F. Competitive additive A only inhibits sludge. Competitive additive B only disperses sludge. Fuelguard provides two-way sludge protection.



Fuelguard Treated Oil

Untreated Oil

Corrosion test on steel in the presence of water and fuel oil.

Full advantage of expanding fuel oil markets goes to the refiner who can supply more cracked fuel oils of *straight-run quality*.

Fuelguard is the additive providing full quality control for fuel oils.

Sludge-Free. Fuelguard's two-way sludge control prevents clogging of filters and burners. Fuelguard inhibits gum and sludge formation AND disperses any existing sludge . . . gives the double action needed for sludge protection, as shown in photographic test results above.

Lighter Color. Fuelguard gives lighter, clearer fuel oils with full sludge control. The light colored, haze-free appearance gives real sales appeal to fuels.

Rust Protection. Fuelguard controls rusting and corrosive pitting of fuel oil tanks and pipelines whenever water is present. Test strips, at left, show Fuelguard control of this destructive action.

No Emulsions. Fuelguard does not emulsify water in the fuel oil or leach out of fuel oil into water layers.

No Sparking or Deposits. Fuelguard is completely combustible and ashless—no metallic ash to cause deposits and exhaust sparking.

If your problem is preventing sludging and excessive darkening of distillate fuel oils, you'll find Fuelguard the economical solution. Fuelguard is available in drums and tank cars for your immediate protection.

Fuelguard

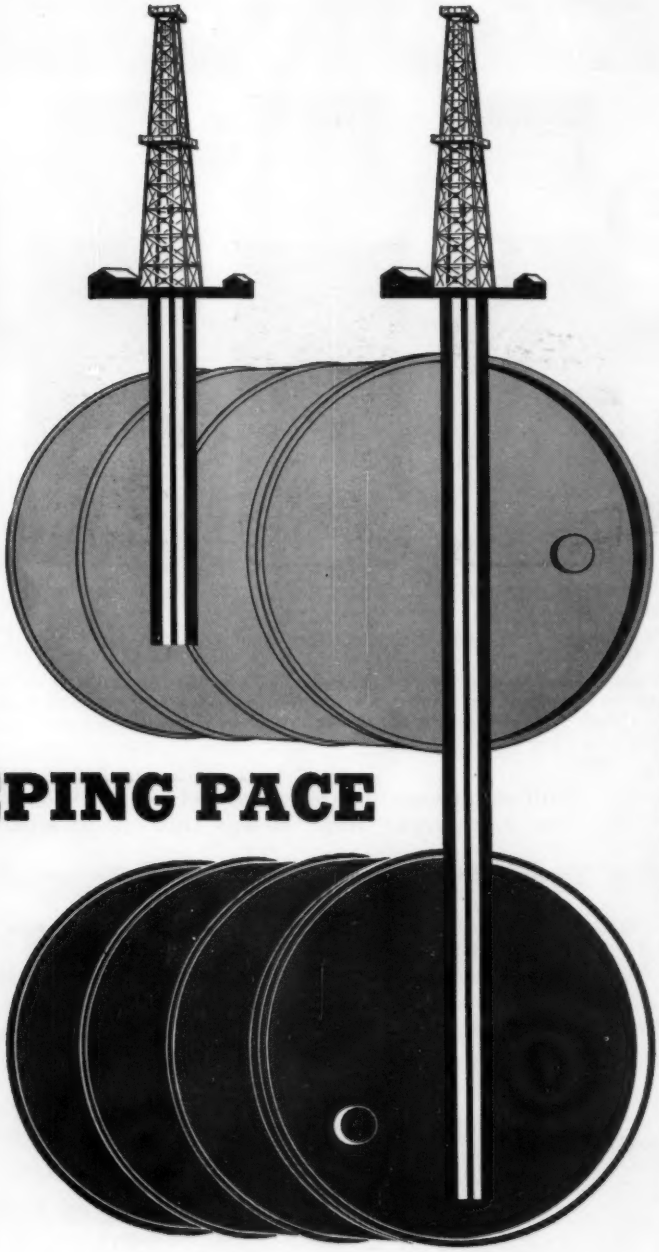
FULL QUALITY PROTECTION FOR FUEL OILS AND DIESEL FUELS

ASHLESS

Manufacturers of fine industrial chemicals

Carlisle Chemical Works, Inc.

Reading, Ohio



KEEPING PACE

Drills were chewing their way down for about 2000 feet in the search for oil in 1916. Today's drilling depth is more than double that.

The change in drilling that forty years has brought well symbolizes many advances in the petroleum and chemical industries. Engineers have dug more deeply into the secrets of nature, too . . . have designed plants and processes to wrest new products and services from petroleum, ores and elements.

We mentioned 1916 because that is the year Sun Ship was founded. It has long served the swift-growing needs of petroleum and chemical industries. Year by year, the engineering skill and facilities of the great Sun Ship plant have proven their ability to meet the demands for plant and equipment keyed to the swift pace of progress in these and other important fields. Sun Ship keeps pace with progress.

Sun

SHIPBUILDING & DRY DOCK COMPANY

SINCE 1916

ON THE DELAWARE • CHESTER, PA.

What Suppliers Are Doing . . .

Erich

Earl Erich has been named sales manager of the Tube Turns Plastics, Inc.

Erich, a specialist in solving corrosion problems, was born in Allentown, Pa., and received his B.S. degree in chemistry from Muhlenberg College. He began his career as a research chemist for The Atlas Mineral Products Co. Later he organized the company's Thermoplastics division.

Erich joined the technical service staff of Tube Turns Plastics, Inc. in January, 1955. In May, 1955, he was placed in charge of sales programs on the west coast and in the southwest. He was made assistant sales manager in January, 1956.

Brister

Paul M. Brister has been appointed manager of the engineering design section of The Babcock & Wilcox Co.'s Manufacturing Engineering department.

Brister joined B&W in 1936, and served in various capacities in the Engineering department. He was made chief of Staff Engineering in 1953, and Engineering department coordinator one year later.

A graduate of Cornell University, Brister has been active on several subcommittees of the ASME boiler and pressure vessel committee, and on the joint ASTM-ASME committee on effect of temperature on the properties of metals.

Kearns

John E. Kearns has been appointed manager of a new district sales office at San Francisco, for The Bristol Co.

Kearns has been with Bristol since 1936. He has served as sales and service engineer at the company's New York, Birmingham, and New Orleans offices. For the past four years he has been in the Application Engineering department at the home office, specializing in automatic control.

He graduated from the Massachusetts Institute of Technology in 1932 with a B.S. degree in electrical engineering.

Williams

James P. Williams has been appointed manager of engineering and planning at the Kaiser Steel Corp. plant, Fontana, Calif. He will have responsibility over plant engineering, metallurgy and inspection, industrial engineering and production planning.

Williams graduated from the Michigan College of Mining and Technology, Houghton, Mich. He received his M.S. degree in metallurgy at the Colorado School of Mines. He joined Kaiser Steel as chief industrial engineer in 1945 after leaving Geneva Steel where he had been plant industrial engineer.

Potter

Robert Potter has been appointed New England sales manager for the Alloy Tube division of The Carpenter Steel Co., Union, N. J.

Potter has had extensive sales experience in several fields, including the plastics industry. He studied mechanical engineering at Bucknell University. In his new capacity, Potter will represent Carpenter in the sale of stainless and specialty welded steel tubing and pipe, and also sheet and plate forms.

Broderick

R. L. Broderick has been appointed Houston district manager for the Autronic Process Controls Division of The Swartwout Co., Cleveland, Ohio.

Broderick has been associated with Swartwout for several years in the Cleveland plant, most recently as project engineer of the Autronic Process Control division and previously as application engineer in the Power Plant Equipment division. Prior to joining Swartwout, he was with the Lewis Flight Propulsion Laboratory of the National Advisory Committee for Aeronautics as a research scientist.

Huke

Frank B. Huke has been appointed sales manager of Norton Co.'s newly formed Electro-Chemical division. He will continue to serve as chief atomic products engineer, a post he has held since he joined the company in January, 1955.

Huke has been associated with atomic energy projects since the early days of World War II when he served as a research assistant on the metallurgical project at the University of Chicago. He later served as a chemical engineer on the Manhattan project; spent four years as a chemist at the Atomic Research Institute at Iowa State College; and before joining Norton Co., was a technical assistant to the director of production of the New York Operations Office of the United States Atomic Energy Commission.

Hammond

E. Weston Hammond has been appointed district manager of the Worthington Corp. Los Angeles district office. Formerly Assistant Manager this office, Hammond will replace **J. G. Murphy** who has been appointed Special Representative.

A graduate of the Massachusetts Institute of Technology, Hammond joined Worthington in 1922 as a student engineer at the corporation's Buffalo division. Prior to his appointment as assistant manager Hammond had served as distributor supervisor of the Air Conditioning and Refrigeration division.

Fisher

E. W. Fisher has been named manager of the newly created Product Engineering department within The Garlock Packing Co.

A graduate of the University of Rochester with a B.S. degree in mechanical engineering, Fisher joined Garlock in 1933. He aided in developing Garlock's functional testing department and later was manager of the oil seal division of the Service department, later becoming manager of the Service department prior to the promotion to his present post. He is a member of the American Society of Lubricating Engineers and an associate member of the American Water Works Association.

Donatic

Ernest F. Donatic has been named general superintendent at the Kaiser Steel Corp. plant, Fontana, Calif. Formerly assistant general superintendent of services, Donatic will assume responsibilities in coordinating the activities of the Iron and Steel, Rolling Mills, and Services divisions at the plant.

He joined Kaiser Steel in 1946 as assist-

Suppliers . . .

ant superintendent of maintenance following 23 years with Republic Steel, Chicago, where he had been assistant superintendent in charge of electrical maintenance and crane repair. A native of Chicago, he attended the Illinois Institute of Technology, majoring in electrical engineering. An active member of many national and local engineering societies, Donatic has won recognition in the steel industry for technical papers on maintenance problems. A professional electrical engineer in California, he is a member of numerous technical societies.

Servo Mex, S. A., Mexico City, has been appointed exclusive sales agency for **Conoflow Corp.** in Mexico.

Carlos Delgado, principal of the organization, received his advanced education in the United States, graduating from Texas Christian University in 1938 as a chemistry major. After completing his formal education, Delgado spent seven years with the Seagrams Distillers Corp., and later Fischer & Porter Co., as a sales engineer. In 1952 he returned to Mexico to set up Fischer & Porter De Mexico, S. A. He served as general manager of this company until 1955 when he founded his own sales agency to represent a selected group of control valve and instrument manufacturers.

CHEMICAL & MECHANICAL ENGINEERS
are offered opportunity to advance professionally in diversified growth company

Air Products offers you the opportunity to advance professionally and financially in the field of low temperature processing. The company is the leader in the engineering, design, manufacture, and construction of oxygen plants and systems for the separation of gases such as Oxygen, Nitrogen, Carbon Monoxide, Hydrogen, and other low boiling building blocks of the chemical industry. We must expand the entire organization to meet the increasing demands of the steel, metallurgical, and chemical industries.

The following opportunities are available at Air Products:

- PROCESS DESIGN: To apply thermo-dynamics, fluid flow, heat and mass transfer, distillation, absorption and adsorption to the commercial solution of complex gas separation problems.
- ESTIMATING AND ECONOMIC EVALUATION: To study and evaluate the economics of proposed systems and to estimate the cost of complete plants.
- PROJECT ENGINEERING: To coordinate the engineering, design, and construction of complete plants.
- MECHANICAL ENGINEERING: To design turbines, pumps, engines and special machinery to operate at extremely low temperatures. To coordinate the manufacture, procurement, installation and operation of large compressors, drivers and other machinery for the processing of gases and liquids.
- DESIGN ENGINEERING: Process equipment, pressure vessels, piping, structural, plant layout, electrical, instrumentation.
- CONSTRUCTION ENGINEERS: Supervision, start up, and operation.
- RESEARCH AND DEVELOPMENT: To explore new horizons in processing and equipment design. Analytical, experimental, design, pilot plants.
- SALES ENGINEERING: To negotiate the sale of complete low temperature systems for chemical, petroleum, metallurgical, industrial and government requirements.

Openings exist for all levels of experience. Training and rotation are provided. High salaries are combined with a profit sharing and bonus program. Professional development is encouraged—growth is continually creating new managerial positions.

This well diversified company offers an unusual challenge for engineers who seek a professional career in the atmosphere of a dynamic, growing company.

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B. H. VanDyke, Air Products, Inc., P.O. Box 538, Allentown, Pa.

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Kaiser Steel Corp. has appointed **Reynold C. MacDonald** division superintendent of Rolling Mills at the Kaiser Steel plant. He was formerly superintendent in the blooming mill area.

A native of Billings, Mont., MacDonald received his education in California schools, attending Los Angeles City College where he majored in mechanical engineering. He joined Kaiser Steel in 1946 in the Industrial Engineering department. He transferred to the rolling mills and worked as foreman and general foreman in conditioning yards, then as assistant superintendent in the merchant-skelp mill, before assuming his post as superintendent in the blooming mill section in 1953.

Babcock & Wilcox Co. has appointed **Robert K. Allen** superintendent of product development at the Alliance, Ohio, Research Center. He succeeds the late G. A. Watts.

Allen joined B&W in 1936 as a student engineer in New York following his graduation from the University of Colorado School of Mechanical Engineering. After serving in Boiler division engineering in New York and Pittsburgh, he was made supervising engineer in New York in 1951 and assistant chief staff engineer in 1955.

Panellit, Inc., has appointed **Louis G. Good** manager of the Contracting division of its Service Corp. As manager of the Contracting division, Good is responsible for the design and complete field installation, test and calibration of instrumentation systems and data reduction systems.

Robertshaw-Fulton Controls Co. has announced the acquisition of **The Beta Corp.,** Richmond, Va., manufacturers of specialized vibration monitoring equipment. Beta Corp.'s operation will be moved to Philadelphia and consolidated with the Fielden Instrument division, a unit of Robertshaw-Fulton.

Russell & Stoll Co., New York, has announced the election of officers. They are: **Albert F. Stoll,** chairman of the board; **Frank L. Novak,** president; **Alexander Hammond,** executive vice president and treasurer; **Thomas H. Hannon,** vice president in charge of sales; **Edward M. Rothen,** vice president in charge of engineering; and **J. A. Heinzelman,** secretary.

A. W. Cash Co., Decatur, Ill., and its subsidiary, Cash Standard Stacon Corp., have announced the appointment of the **K. C. Brown Co.,** Kansas City, Mo., as their representative in Kansas and western Missouri.

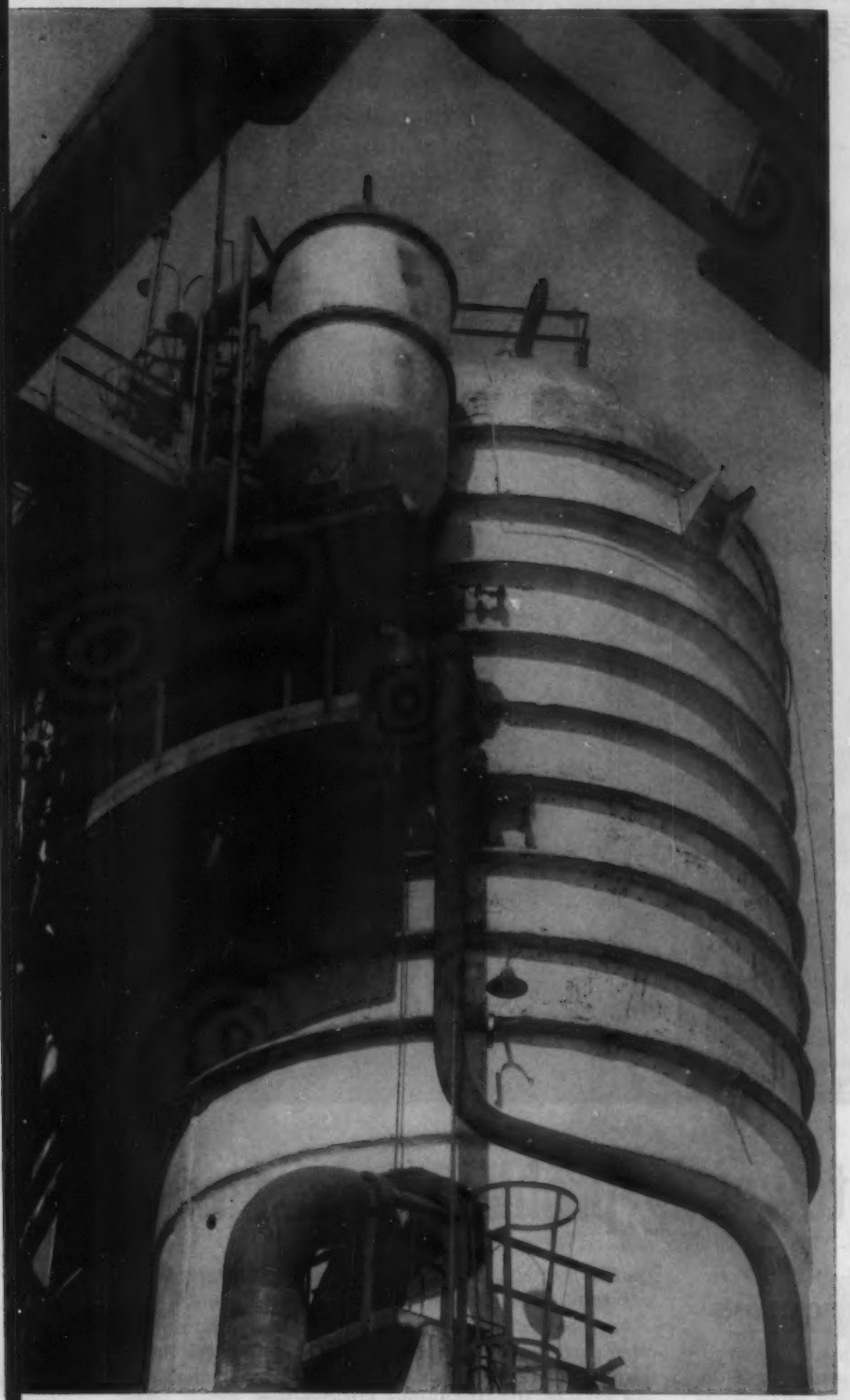
The new representative will be sales agents for the Cash Standard and Cash Standard Stacon lines.

The Permutit Co. has appointed **Durando Miller** technical manager. Miller will be responsible for decisions concerning industrial treatment processes to be used, performance guarantees, the use of pilot plants for specific field problems and other technical matters.

Miller has been with Permutit since 1938 and has served as assistant technical manager since 1953. He is the author of many papers on water conditioning, and for 3 years was an instructor in industrial water treatment in sanitary engineering at New York University.

Norton Co. has appointed **Richard H. Harris** assistant controller. This appointment adds a second assistant controller to

STAINLESS STEEL SOLVES



CORROSION PROBLEM

in 740° F. vacuum evaporator

AT SINCLAIR'S
MARCUS HOOK REFINERY

Sinclair Refining Company operates a light distillate refinery at Marcus Hook, Pa. Some of the products are gasolines, kerosenes, propane, xylene, toluene, paraxylene, Bunker C and Navy Special fuel.

Two vacuum evaporators take the reduced crude and remove from it gas oils (as overhead products) and asphalt (as bottom product), and the latter is upgraded into heavy fuel by visbreaking. The evaporators operate at about 740° F.

The carbon steel vessels were originally unlined, but inspection showed that they were failing rapidly. Essentially, this was high-temperature sulfur corrosion, coupled with severe erosion caused by the reduced crude entering under pressure into the vacuum.

The evaporators were promptly lined with type 410 Stainless Steel sheets in the flash sections, and, *in five years of service*, the sheets show little signs of wear. In fact, engineers expect the Stainless sheets to last at least another five years—more probably ten.

For refinery corrosion and erosion problems, think of Stainless Steel. For service-tested quality, specify *USS* Stainless Steel.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
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USS STAINLESS STEEL

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7-59

UNITED STATES STEEL

Each a towering problem solved with

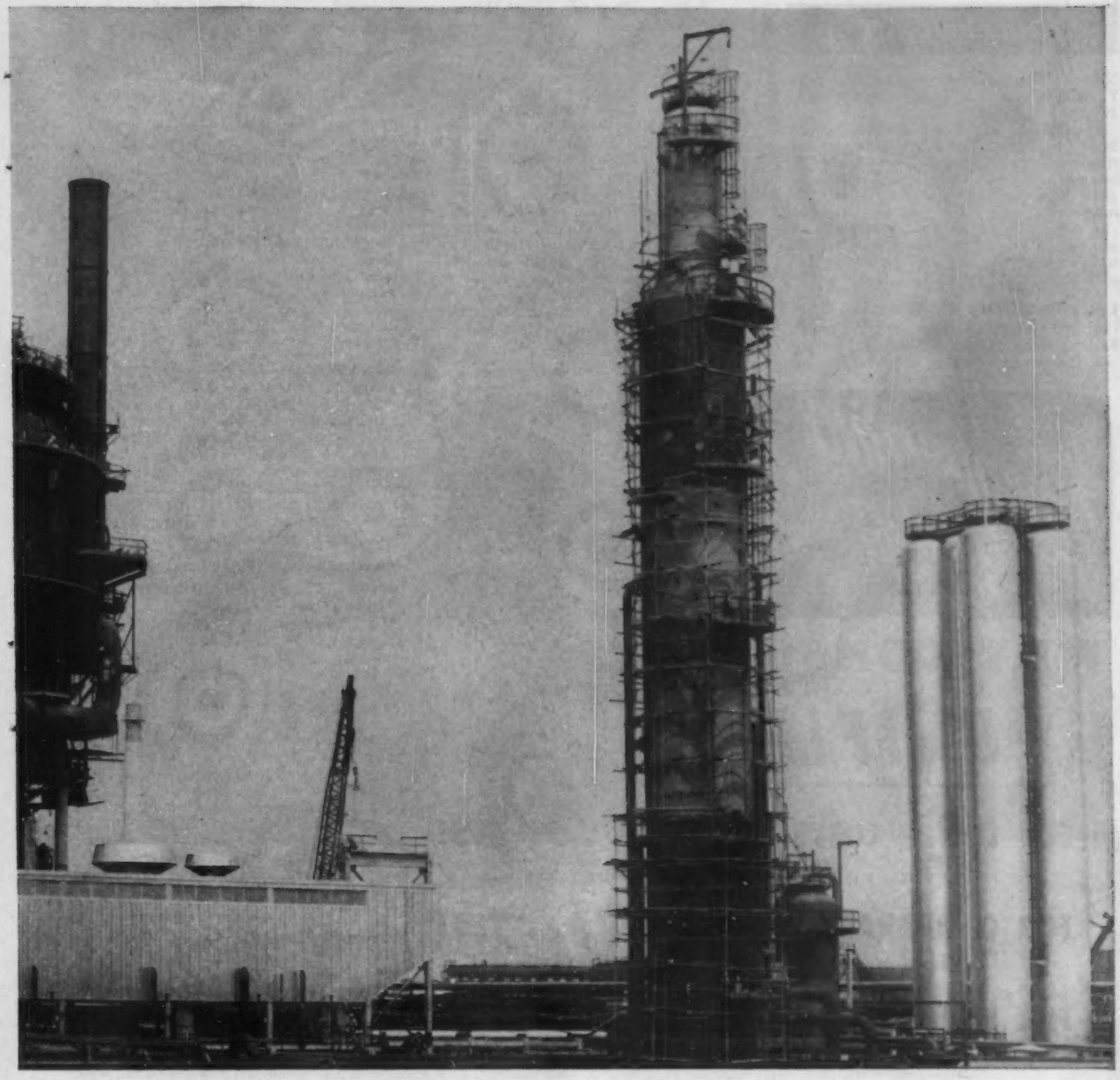
NEW TIDEWATER DELAWARE FLYING A REFINERY TAKES 12 TYPES—1,800 TONS

Choosing from the widest range of such materials available from any source, designers and fabricators for Tidewater carefully selected Lukens clad and alloy steels for the heart of its new Delaware Flying A Refinery.

To resist the corrosive attack of sulfur compounds and naphthenic acid—Lukens stainless clad types 316-L, 405 and 410; for chlorides—Lukens Monel-clad; for high-temperature service—Lukens A-204 alloy; to resist hydrogen attack and graphitization and for strength at high temperatures—Lukens A-301 alloy.

And for economical protection against a variety of other corrosive and abrasive problems Tidewater chose 6 additional types of Lukens clad steels—Inconel, nickel and copper; 304, 304-L and 316 stainless.

Lukens clad steels offer all the protection of solid high alloy—economically. The bond is permanent; you can use the combined gage of cladding and backing metals in designing to meet Code requirements. Flanges and pipes can be welded on, even after vessel installation.



Lukens clad and alloy steels

Consult your equipment builders, or write for the new **Clad Steel Equipment** bulletin and information on alloy steels. Manager, Marketing Service, Room 897, Lukens Steel Company, Coatesville, Pa.

This is Lukens clad steel, a proven product. Not a lining, not a soldered-on surface, but a solid steel plate—one side corrosion-resistant high alloy, the other economical alloy or carbon steel permanently bonded on powerful rolling mills.

LUKENS ®

Helping industry choose steels that fit the job

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Norton's financial staff in addition to **John F. Dingle** who has held the post since 1955.

Harris, 30, was born in Worcester, Mass., graduated from Massachusetts Institute of Technology with a degree in business and engineering administration in 1948 and obtained his M.S. degree the following year.

Joining Norton in July, 1949, he became assistant to the director of factory training and a member of the controller's staff in January, 1950.

Laclede-Christy Co. Division, H. K. Porter Co., Inc., has appointed **Walter D. Roberts** head of the Exploration department. Roberts will direct the development of raw material reserves for the manufacture of refractories at all Laclede-Christy works.

Roberts is a geology graduate of Muhlenberg College and attended Lehigh University and Washington University. He was with Coplay Cement Manufacturing Co. and St. Joseph Lead Co. He is a member of AIME and the Association of Missouri Geologists.

General Electric Co. has announced that **S. Lee Elliott** has joined the company's Metallurgical Products department, Detroit, as an equipment development engineer. His new duties include the development of machines and equipment for the manufacture of cemented carbides.

Elliott is a graduate of the University of Michigan, holding degrees in both industrial-mechanical engineering and industrial management. He joined the General Electric Co. in 1953.

Tracerlab has announced the appointment of **Watson Greenfield** as treasurer of the company.

Greenfield has had over 15 years of broad and varied experience in accounting and financial management. He was formerly treasurer and member of the board of directors of the George E. Keith Co., Brockton, Mass. He has been controller and a member of the operations committee of Craig Systems, Inc., in Danvers, Mass., and was associated with Lybrand, Ross Bros. & Montgomery as senior accountant in charge of field assignments.

He is a graduate of the University of California and the Harvard Business School.

John Wood Co. has announced that **George M. Hale,** Little Rock district sales manager for Bennett Pump division, has retired after more than 30 years service with the petroleum industry.

Hereafter, Bennett Pump division will be represented in Arkansas by Rittiner Equipment Co., Little Rock. Rittiner has sold Bennett products in Louisiana for many years and is establishing a Little Rock branch to serve the area.

Westinghouse Research Laboratories has appointed **Dr. Clarence Zener** director of the company.

Dr. Zener assumes his new post after five years as an associate director and a year as acting director of the staff of the laboratories.

Formerly a professor in the Institute of Metals department of Physics at the University of Chicago, Dr. Zener is author of the Zener theory of ferromagnetism which explains why certain materials are strongly magnetic, and of the Zener effect, a theoretical explanation of the electrical breakdown in semiconductors such as germanium and silicon.

Dr. Zener, a native of Indianapolis, Ind., received his B.S. degree from Stanford University in 1926 and his Ph.D. degree in physics from Harvard University in 1929.

Mason-Neilan, Division of Worthington Corp., has appointed **Eric A. Bianchi** vice president in charge of engineering, and Paul Wing, Jr. to chief engineeer.

Bianchi has been a member of the Mason-Neilan organization for 25 years, serving in various sales and engineering capacities, most recently as director of engineering. Wing, a 12-year veteran, was formerly manager of the Product Application Engineering department.

United States Steel Corp. has appointed **Truman H. Kennedy,** general superintendent of the Lorain, Ohio, Works. **Louis F. Sattele** has been named to succeed Kennedy as general superintendent of the Division's National Works, McKeesport, Pa.

Kennedy succeeds **Robert Urquhart** who has been transferred to the Division's headquarters offices in Pittsburgh.

Kennedy is a graduate of the School of Mines and Metallurgy of the University of Missouri where he received a B.S. degree in metallurgy. From 1933 until 1940 he held various positions with the Inland Steel Co. and the Interlake Iron Corp. He joined the National Tube division in 1940 as assistant superintendent of blast furnaces and the following year was made superintendent of the furnaces. On January 1, 1946, he became assistant

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(25% to 50% Lower)

FOR COMPARABLE CAPACITY? . . . . YES!
(Equal or Better Than Conventional Designs)

FOR HIGHER EFFICIENCY? . . . . . YES!
(Closer Approach to Equilibrium)

FOR MAXIMUM FLEXIBILITY? . . . . YES!
(Wide Operating Range)

FOR MINIMUM MAINTENANCE? . . . YES!
(Simplified Installation, Self-Cleaning Characteristics)

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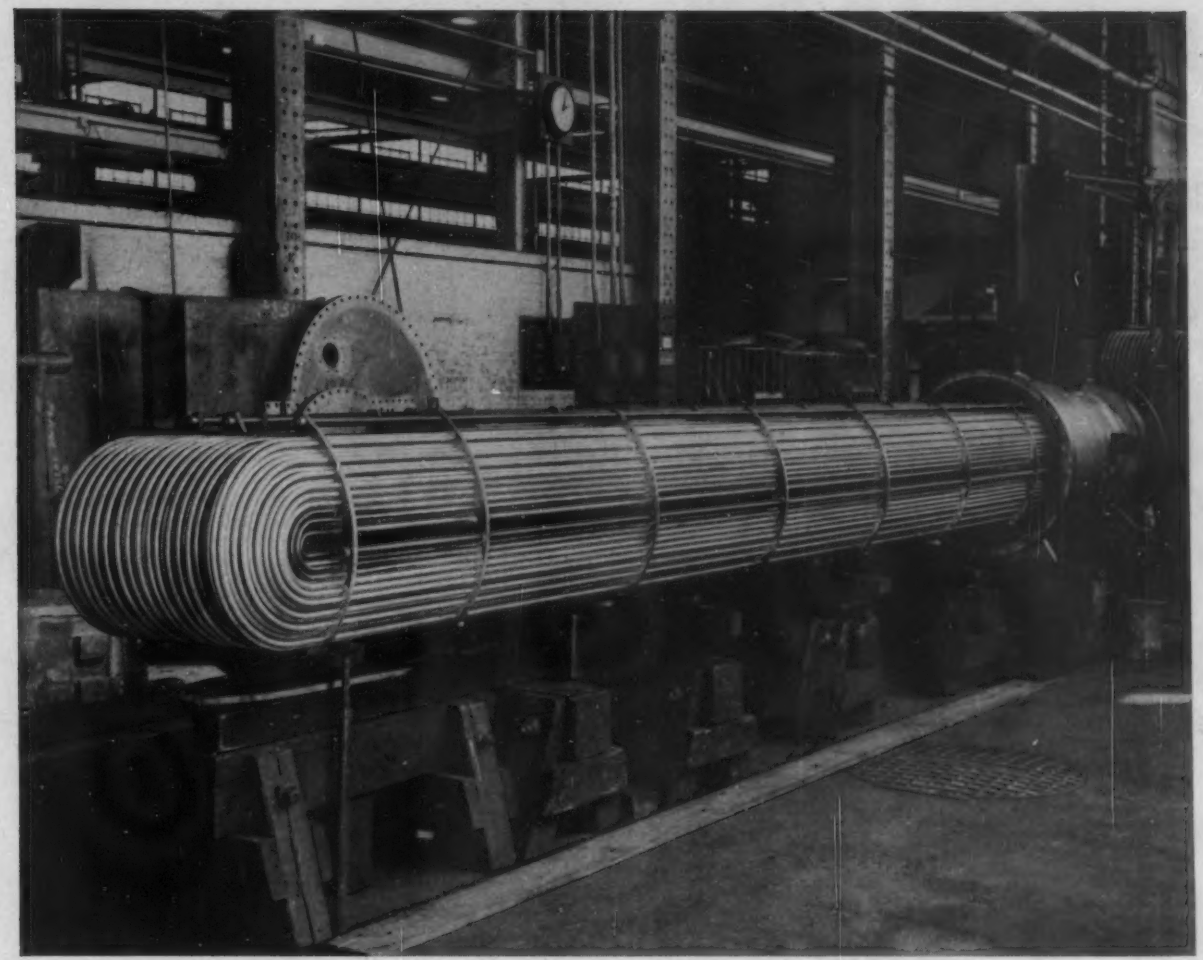
For more data on advertised products, use Readers' Service Cards, last page.



U-Bend Tubes of Anaconda Arsenical Admiralty-439 assembled in a bundle for a horizontal feed-water heat exchanger by The Griscom-Russell Co., Massillon, Ohio.

Arsenical Admiralty U-Bend Tubes make a compact power station feed-water heater

THIS compact tube bundle contains 436 Anaconda Arsenical Admiralty-439 tubes, 5/8-inch OD x .049-inch gage, averaging 45 feet long. The bundle is now operating in a power station feed-water heater.

The American Brass Company is constantly studying corrosion problems affecting condensers and heat exchangers—and is a leader in the development of alloys to help meet these problems. Arsenical Admiralty-439 is but one of its many contributions in the field.

Full Range Available. Anaconda heat exchanger and condenser tubes are made for all sizes and kinds of shell-and-tube, submerged, spray-tower, and finned-atmospheric heat transfer equipment – for operation at elevated temperatures in conformance with ASME standards for allowable stresses.

Technical Assistance. The Technical Department of The American Brass Company is regularly helping manufacturers, power companies, marine operators, petroleum and chemical companies to select the correct tube alloy for many types of condensers and heat exchangers. This service is available to you without obligation. Write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

ANACONDA®

Tubes and Plates for Condensers and Heat Exchangers

Suppliers . . .

general superintendent, and general superintendent in 1948.

Mr. Sattele, who before his new appointment was assistant general superintendent of National Tube's Lorain Works, is a native of Pittsburgh and graduated from Carnegie Institute of Technology as a metallurgical engineer. Immediately upon graduation he joined National Tube at Lorain in the operating department.

National Aluminate Corp. recently expanded its technical service organization in southern California with the addition of two new field representatives, **Thomas R. Bell** and **William H. Rodewald.**

Rodewald, transfered from Nalco's main office in Chicago, has been a sales engineer in the petroleum and petroleum chemical field for seven years. Bell is an engineering graduate of the University of Southern California.

Revere Copper and Brass Inc. has appointed **T. Watson Outwater** as a special representative in Charlotte, N. C., handling the company's welded steel tubing and forgings lines and other manufactured products. Outwater had been New York district manager.

Rockwell Manufacturing Co. has begun construction on a new 35,000-square-foot valve parts plant for Valve Products, Inc., subsidiary of Rockwell.

Located on a 20-acre site northwest of the Starke county airport, the ultramodern plant will be of high bay construction and modular design, so constructed that further additions can be built in three directions.

McJunkin Corporation, industrial supply house, has been appointed distributor in the Pittsburgh area by the Alloy Tube Division, Union, N. J., of The Carpenter Steel Co.

McJunkin will sell and service Carpenter's full line of stainless tubing and pipe, and will serve users throughout western Pennsylvania.

As new distributor for Carpenter, McJunkin will work jointly with **John Mitchell,** the Tube Division's Pittsburgh territory manager. **William Beegle** is manager of the McJunkin branch office.

Rockwell Manufacturing Co., Meter and Valve division has expanded its Denver branch office into a full district office. **Orville Cochran,** Denver branch manager, has been promoted to district sales manager.

A native of Livingston County, Mo., Cochran served as a sales engineer for Rockwell in the Rocky Mountain territory for more than 25 years before being named branch office manager in 1955, when the Denver office was opened. He joined the company in 1922, spending his first eight years in the Kansas City district office.

Raybestos-Manhattan, Inc., Manhattan Rubber and Packing division has expanded its field sales force to better serve expanding markets. This has prompted the division of the country into four sales regions, each headed by a regional manager. These are supported by district managers, responsible for supervision of field salesmen's activities.

The new regional managers and their respective district managers are:

R. F. Teeling, eastern regional manager, with **Stewart Monroe** as New York district manager, **J. T. M. Frey,** New Jersey district manager, and **F. McBrearity** Philadelphia district manager.

A. L. Hawk, central regional manager, with **A. N. Johnston, Jr.,** as Pittsburgh district manager, **G. S. Himebaugh,** Chicago district manager, and **E. T. Fair,** Denver district manager.

C. P. Shook, Jr., southern regional manager, with **A. A. Ringland** as Birmingham district manager, **A. E. Jackson,** New Orleans district manager, **E. W. Nagel,** Dallas district manager, and **R. C. Nielson,** Houston district manager.

S. V. V. Hoffman, western regional manager, with **R. B. Park** as San Francisco district manager.

Delta Tank Manufacturing Co., Oilfield Equipment division has appointed **Rayburn Noland** as field sales and service engineer. Noland is a veteran of the oil industry, having previously been active in sales and service of oil and gas processing equipment in the southwestern United States.

Kaiser Steel Corp. has appointed **Gordon A. Zwissler** as assistant general superintendent in charge of services. In his new post Zwissler will have charge of maintenance, utilities, the railroad, and other services at the plant. He was pre-

reodorize petroleum malodors with Alamask!

Make olfactorily acceptable petroleum products!

Producers of petroleum products and of petro-chemicals — by adding a selected ALAMASK reodorant — can improve odor characteristics of such materials. A specific ALAMASK is available to achieve adequate reodorization of a variety of petroleum products.

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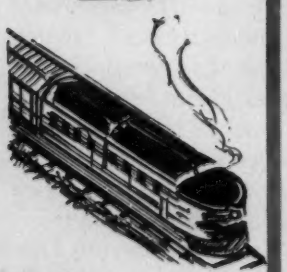
FUEL OILS (regular or premium gasoline blends)
KEROSENE
DIESEL OILS
CUTTING OILS and SPECIALTIES
many other petroleum products



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RELIABLE CONDENSER TUBES

EXTENDED SURFACE WELL ACCEPTED IN FACT AND THEORY

Increased heat transfer effectiveness, because of the greater surface area realized through the use of fins, is a well established principle. In recent years its use has become increasingly widespread because of Wolverine Tube's development of condenser tubing with fins actually extruded from the tube wall.

The further development of Trufin Type S/T, with 19 fins per inch, has permitted extended surface to be applied, for the first time, to conventional shell and tube heat exchangers. Equally important is the fact that it is as easy to use as plain tube. Here's why:

The fins are spirally extruded from thick-walled tube to a height of approximately 1/16 of an inch. The extrusion process produces a smooth fin development without any sharp angles or crevices. Tube ends are left without fins and the tube is designed so that the O.D. of the plain end is slightly greater than the O.D. over the fins. This permits it to be inserted into bundle and rolled into the tube sheet in the regular manner.

Because the fins are part of the tube itself they are little affected by excessive vibration, thermal shock or varying pressures.

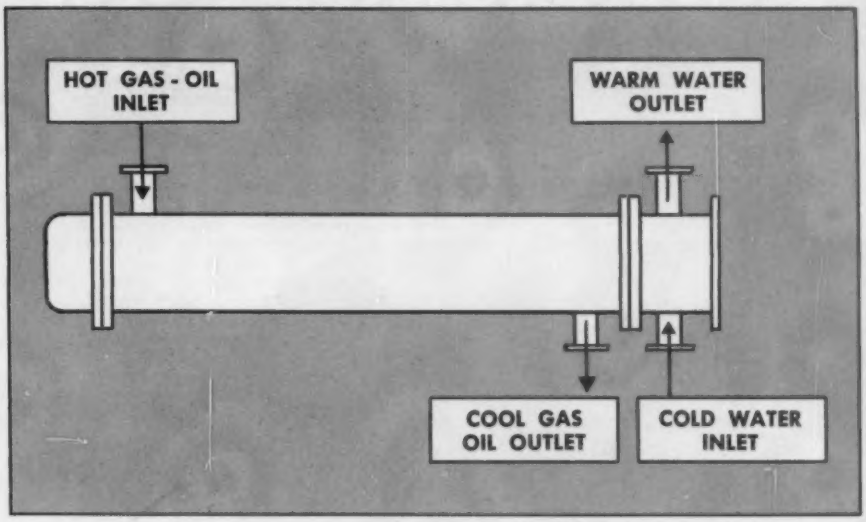
For complete information about Wolverine products and services write for your copy of the Wolverine Condenser Tube Book.

WRITE FOR FREE BOOK

Valuable design information, actual case histories and descriptions of Trufin applications are all contained in Wolverine's Trufin Opportunity Book.

This valuable book is one of the most comprehensive ever compiled on the use of extended surface condenser tube and can be of great help as a reference book to processing engineers.

The Trufin Opportunity Book is available without charge. Write for your copy—TODAY.



Trufin Type S/T Scores Again!

120% BOOST IN HEAT TRANSFER SERVICE UPS HEAT DUTY AND ON STREAM TIME

By Ernest Dodd

There's no doubt about it. In the east, west, north and south, word is spreading fast about the amazing results obtained when using Wolverine Trufin® Type S/T condenser tube in various heat transfer applications.

This time, it's a refinery in the mid-west reporting—telling of a retubed heavy gas oil cooler using water as the coolant. Heat transfer was increased, cooling oil outlet temperature was dropped 10° to 15°F. and on-stream time stepped up 350%!

How does Trufin Type S/T accomplish these outstanding performance boosts? The answer isn't hard to find.

Type S/T is an extended surface tube specifically designed for shell and tube heat exchangers. Because of its integral fins – they're actually a part of the tube wall—Type S/T has approximately 2½ times more heat transfer surface than does plain tube. The result is more BTU's from each foot of tube. In this case, for example, the oil cooler, when tubed with plain tube had a total of 275 ¾"O.D. x 16 BWG x 16′ long Admiralty tubes. When retubed with Trufin Type S/T, exactly the same number of tubes—275—of the same O.D., alloy and length were used. There was, however, one startling difference.

The oil cooler unit tubed with prime surface tube had 865 square feet of heat transfer surface. WHEN RETUBED WITH TRUFIN TYPE S/T, OUTSIDE TUBE SURFACE AREA JUMPED TO 1930 SQUARE FEET—AN INCREASE OF 120%. In those figures lies the answer to Trufin's success.

Wolverine Trufin available in Canada through the Unifin Tube Company, London, Ontario.

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WOLVERINE TUBE DIVISION
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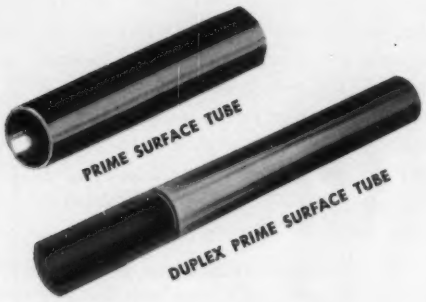
RELIABLE CONDENSER TUBES
by Wolverine Tube

IN THESE POPULAR ALLOYS . . .

PRIME SURFACE TUBE
Inhibited Admiralty
Copper
Cupro-Nickel 10, 20, 30%
Aluminum Brass
Red Brass
Aluminum

DUPLEX PRIME SURFACE TUBE
Can consist of an inner and outer tube formed from any of the above metals.

IN ALL THESE TYPES



FINNED AND PRIME SURFACE U-BEND TUBES

Inhibited Admiralty
Copper
Cupro-Nickel 10, 20, 30%
Aluminum Brass
Red Brass
Aluminum
When specifying in finned form add electric-welded steel to above list.

FINNED AND PRIME SURFACE U-BENDS

FINNED TUBE

TRUFIN TYPE S/T
Copper—70-30 Cupro-Nickel—90-10 Cupro-Nickel
85-15 Red Brass—Admiralty—Electric-Welded Steel
Aluminum Brass

DUPLEX TYPE S/T
Also available in above metals

TRUFIN TYPE H/A
Copper-Aluminum

TRUFIN TYPE H/R
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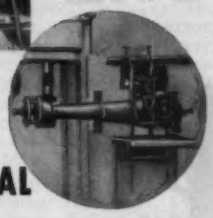
VERTICAL



OR

HORIZONTAL

many more hours on stream without forced shutdown with NATIONAL AIROIL

OIL-GAS TANDEM COMBUSTION UNITS

Exclusively for vertical firing, the new National Airoil VERTICAL Tandem Block Units retain all the features of our regular horizontal Tandem Units . . . **plus:** special, precast refractory shapes for easier, cost-saving vertical installation and maintenance; secondary air inlet louvres for positive control of vertical flame pattern; and, all steel duplex detaching gear which enables swift, simple vertical burner change-over.

VERTICAL and HORIZONTAL Tandem Units hold air in the combustion zone until fuel and heated air are thoroughly mixed. This means that ignition takes place in a hot zone; the result: high fuel economy through more rapid combustion with a minimum of excess air. NATIONAL AIROIL's patented Tandem Combustion Units allow secondary air to be easily and accurately controlled. By adjusting air control louvres, flame can be shaped to radiate heat uniformly without tube impingement.

The VERTICAL or HORIZONTAL Tandem Unit is always fired with NATIONAL AIROIL Combination Oil and Gas Burners . . . has a high turndown ratio with a steady flame temperature using either fuel oil or gas. With the TANDEM UNIT's clean flame, a cold furnace can be brought to full capacity in a short time.

"Many, many more hours on stream, without shutdown" . . . yes, YOU will realize higher profits from YOUR heaters when NATIONAL AIROIL VERTICAL or HORIZONTAL Tandem Units are specified. Our new Bulletin 498 is yours for the asking.

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viously division superintendent in the rolling mills.

A native of Lafayette, Ind., Zwissler graduated from the Armour Institute of Technology with a B.S. degree in civil engineering, later taking postgraduate work in chemistry and metallurgy for two years at the University of Pittsburgh.

From 1936 to 1946 he was employed in various plants of the Carnegie Illinois Steel Corp. and came to Kaiser Steel from the Youngstown, Ohio, works. At Kaiser he was chief industrial engineer, then was transferred to the blooming mill operations where he was appointed superintendent in 1948. In 1953 he became division superintendent.

Borden Metal Products Co. vice president **D. C. McPhee** was elected president of the Metal Grating Institute at the Institute's annual meeting in New York.

The Metal Grating Institute's program for 1957 will include the publishing of the *Metal Grating Handbook*, a design manual for architects, engineers and builders. In outlining the program to the Institute's members McPhee pointed out that *The Metal Grating Manual* will be the first of its kind ever published by metal grating manufacturers.

Allis-Chalmers Manufacturing Co. has appointed **H. R. Godfrey, Jr.**, manager of product sales. A 1948 mechanical engineering graduate of Oregon State College, Godfrey joined Allis-Chalmers in the same year. After completing the company's training course for graduate engineers, he became an assistant engineer in the centrifugal pump department. Two years later he was assigned to the New York district office. In 1956 he became assistant to the general manager of Allis-Chalmers General Products division.

ALCO Products, Inc., has announced the appointment of **T. I. Equipment, Inc.**, Cleveland, its exclusive agent in Northeastern Ohio. T. I. Equipment, Inc., is owned by **Farmer** and **Franklyn W. Kirk.** The firm was founded nine years ago to represent manufacturers in the northeast Ohio area.

Farmer, a native of Saginaw, Mich., is a graduate of the University of Michigan and is registered as a professional engineer in Ohio and Michigan. He formerly was associated with the Commonwealth & Southern Corp. and the H. K. Ferguson Co.

Kirk is a native of New York and attended Cooper Union and City College of New York. Prior to moving to Cleveland he was associated with the Ford Instrument Co. He also has been with the former Tagliabue Instrument Co. and the Ambos-Jones Co. in Cleveland.

Hooker Electrochemical Co., Niagara Falls, N. Y., has announced new appointments among executive and administrative personnel of the former **Oldbury Electro-Chemical Co.**, now the Oldbury Division, Hooker Electrochemical Co.

Dr. Earl L. Whitford, now vice president and director of Hooker, and formerly of Oldbury Electro-Chemical Co., will coordinate the Hooker research programs at Niagara Falls. Other appointments included **Dr. Johannes H. Bruun** as director of research and development; **Dr. Walter**

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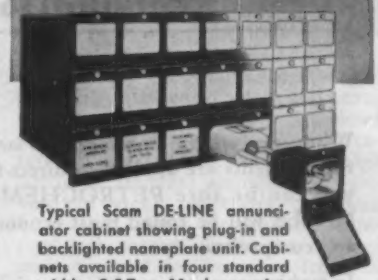

Typical Scam DE-LINE annunciator cabinet showing plug-in and backlighted nameplate unit. Cabinets available in four standard widths, 3-5-7 or 11 alarm points wide, any number high.

Even the most advanced automatic system needs the reliable monitoring that only good annunciators offer. And of those available only Scam gives you the benefit of broad standardization and interchangeability to cover the most specialized requirements. For instance, the DE-LINE annunciator can provide, in one standard cabinet . . .

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3. **Easy adaption for use with Scam DU-ALL annunciators for HI-LO indication.**
4. **Optional ringback or manual reset functions by the operation of a slide switch.**

There are many other standard features of DE-LINE annunciators that are usually provided only on special order – features that make them the most versatile available, capable of "growing" with any control system. Write for literature or call any representative in the cities listed below.

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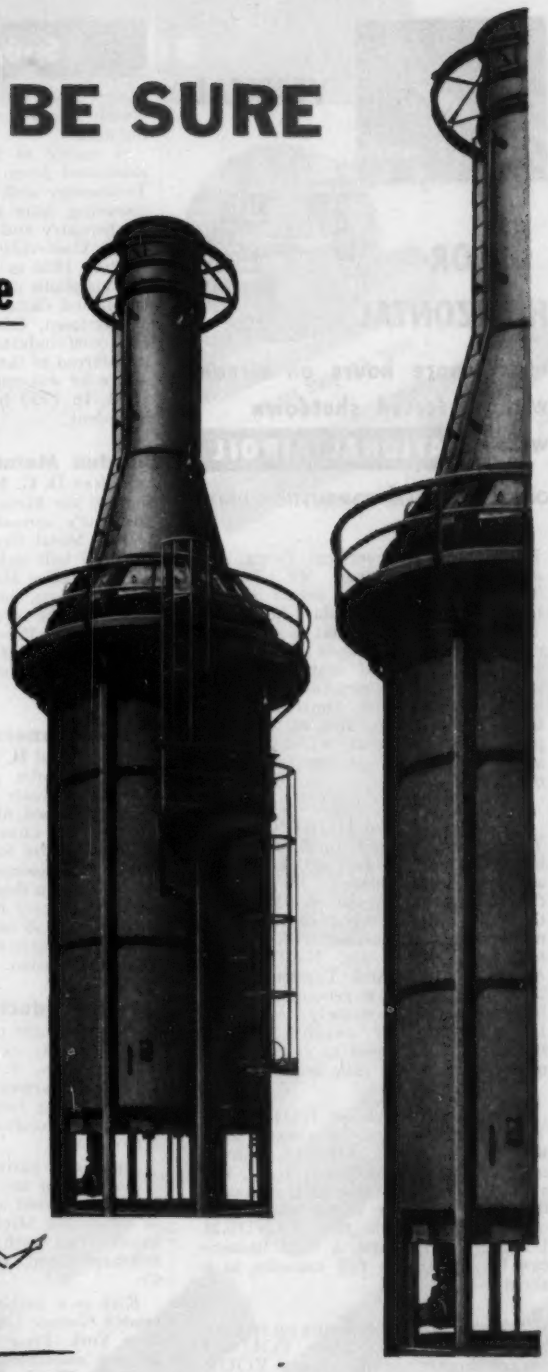

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In making comparisons it is essential to take these factors into consideration:

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H. Prahl as director of research and development, Durez Plastics division; and **Dr. James H. Brown,** as manager of research and development.

Other employees named to new positions in the Oldbury division are: **Dr. Marion B. Geiger,** general manager; **Dr. Clarence A. Stiegman,** technical director; **Maynard L. Parker,** production manager; **Dr. John C. Pernert,** chief research chemist; **Harold L. Townend,** chief engineer; **William H. Streicher,** plant engineer; **Floyd E. MacDonald,** personnel director. **Harry R. Oswald** has been named works manager of the Columbus, Miss., plant.

Sales department appointments for this division are as follows: **Harold N. Fyffe,** general sales manager; **Robert B. Boyd,** sales manager; and **Fred H. Berggren,** assistant sales manager.

Rawson & Co., Houston, has appointed **Robert E. Moore** as a sales engineer. Moore, 30, graduated from the University of Illinois in 1949, receiving a B.S. degree in chemical engineering. He was with the Shell Chemical Corp. at Houston for seven years, serving in the Technological and Operating departments. The last two years Moore was an assistant department manager. Rawson & Co. operates in Texas and Louisiana.

Chase Brass & Copper Co. has moved its office and warehouse business to its own new building at 55-60 58th Street, Maspeth, Long Island. Chase, a subsidiary of Kennecott Copper Corp., operates 25 brass and copper warehouses in principal cities across the nation.

Suppliers . . .

H. K. Porter Co., Inc., has announced that **T. M. Evans,** president, has been elected chairman, and **Charles L. Holbert,** executive vice president, has been elected president. Prior to joining the Porter Co. earlier this year, Holbert was executive vice president of the Southern Pacific Milling Co., Ventura, Calif.

Carrier Corp.'s veteran executive, **James C. Patterson,** has retired after 20 years of service. Patterson had been manager of Carrier's unit heater department and was instrumental in development of mobile home air conditioning. He headed Carrier's mobile homes department since its establishment two years ago.

Besides his reputation in the heating and air conditioning industry, Patterson was an intercollegiate sprint champion and record holder. In 1913 he won the intercollegiate sprint championship going on to the International Games in Denmark in 1914 where he won the 100 meter dash.

Hewitt-Robins, Inc. has elected **F. L. Griffith** and **F. W. Blanchard** as vice presidents. Blanchard will be responsible for manufacturing and engineering in the company's industrial products divisions. During the last six months he has been serving as assistant to the executive vice president, and previous to that was manager of operations of the Hewitt Rubber Division's plant at Buffalo, N. Y. Blanch-

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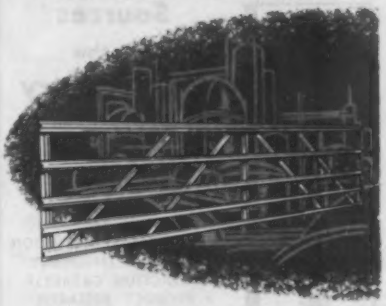

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For more data on advertised products, use Readers' Service Cards, last page.

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ard joined Hewitt-Robbins in 1936 as an engineer and draftsman.

Griffith since 1953 has been general sales manager of the industrial products divisions and will continue in that capacity as a vice president of the company. He has been with Hewitt-Robins since 1949, having started as supervisor of time study and methods in the foam rubber plant at Buffalo. He later became superintendent of the conveyor machinery plant in Passaic, N. J., and then in 1952 moved to the company's executive offices in Stamford where he organized its industrial products central sales department.

Scovill Manufacturing Co., Waterbury, Conn., will expand mill facilities by the purchase of about 93 acres of land located in the northern part of New Milford, Conn.

It is anticipated that construction of the building 1150 feet by 200 feet with necessary service adjuncts on a railroad siding, will start in the spring of 1957. The building of 12 miles of natural gas pipe line is also involved. Approximately 200 persons at the start of operations will be employed.

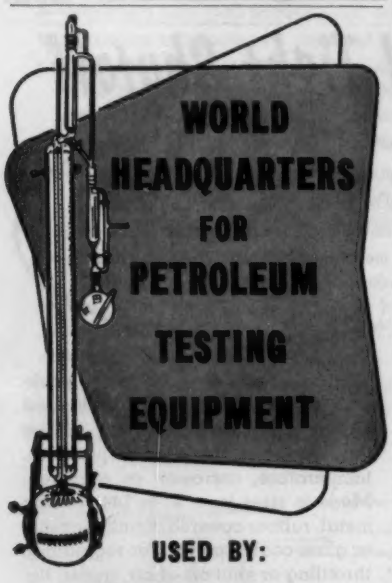
United States Steel Corp. has appointed **Thomas G. Higgins** as field representative of the Oil Well Supply division at Williston, N. D. Higgins was employed in 1955 at the division's Casper, Wyo., store. During World War II he served in the U. S. Marine Corps.

Delta Tank Manufacturing Co. has appointed **Frank M. Black** as Houston area branch manager of its Oilfield Equipment division. Black, a member of the American Petroleum Institute, formerly was affiliated with Humble Oil & Refining Co.'s Production Research department and also served as district engineer and branch and district manager for other equipment firms active in the petroleum industry. His new office is located at 2606 Knobloch Street, Houston 23, Texas.

Black

Peerless Pump Division, Food Machinery and Chemical Corp., has appointed **Max H. Richter, Jr.,** New Orleans, and **George Ries,** Cleveland, as sales engineers. Richter, who attended Louisiana State University, has been assigned to handle sales of the company's engineered vertical and horizontal pump lines in Louisiana and Arkansas. Ries, who attended Cincinnati University, has a similar assignment for Ohio. Both Richter and Ries have been in pump sales for the past four years.

Weston Electrical Instrument Corp., Newark, N. J., a subsidiary of **Daystrom, Inc.,** has announced that **Kenneth C. Moulton** has been appointed manager of the new Weston Los Angeles branch office. A graduate from Stanford



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Material: Carbon Steel
O.D. (shell): 32½"
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Downtime is expensive. The purchaser of a heater must as a result look beyond his initial cost to the long pull. For the long pull, Lummus oil heaters have consistently exhibited great durability while operating efficiently and with an absolute minimum of days lost to maintenance work.

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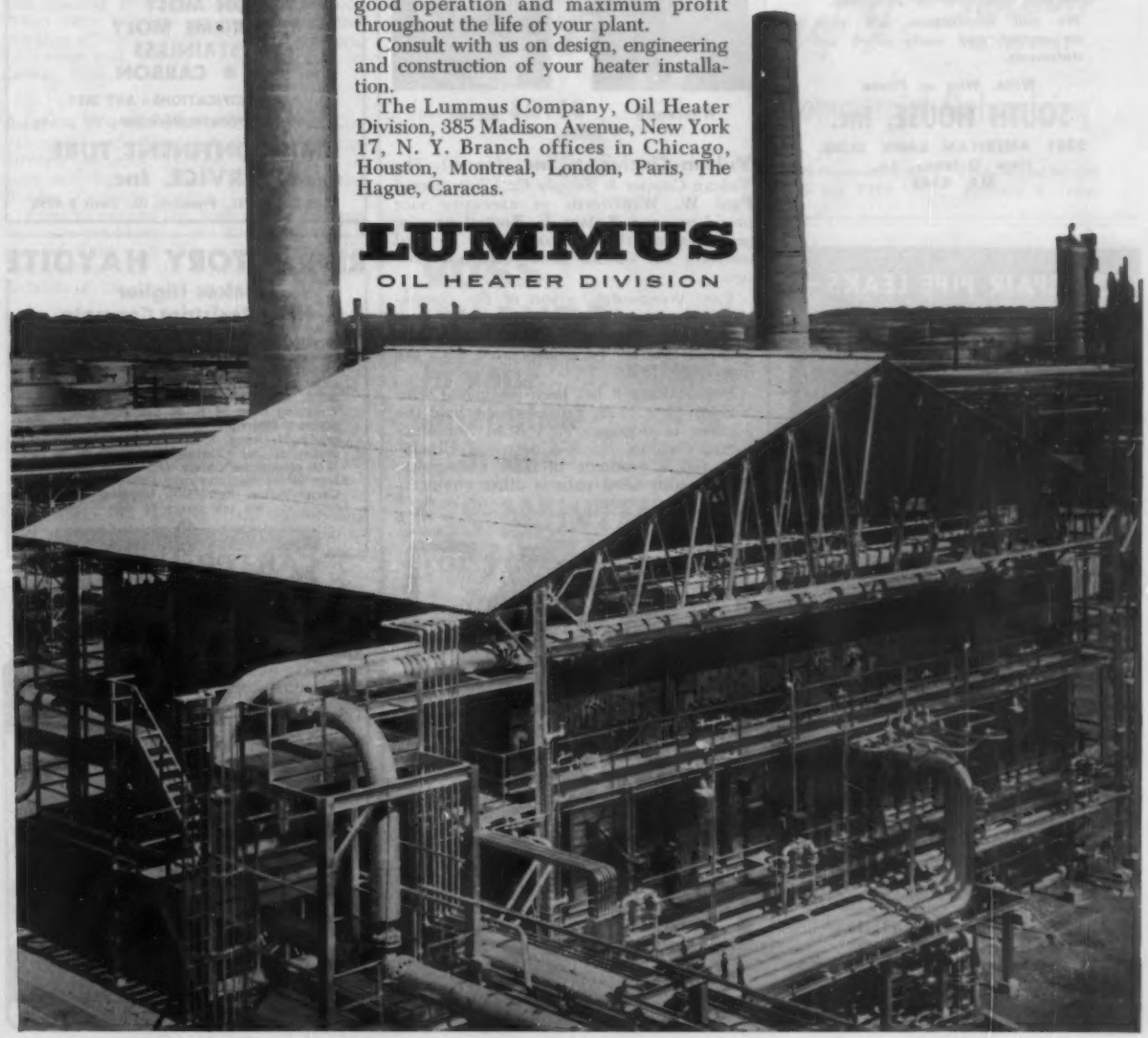
LUMMUS

OIL HEATER DIVISION



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University, he was previously associated with General Electric as a design and field engineer, and recently as Los Angeles sales manager.

Also **Edward B. Annett, Jr.**, was appointed Weston district sales manager for the Cincinnati territory. A graduate of Lehigh University he was previously associated with Western Electric Co., and Pennsylvania Power & Light Co. in the engineering divisions; and also as district sales representative for the Edwards Co., Inc.

At the same time **Dudley K. Bailey** was appointed district sales manager for the Buffalo territory. Bailey has been associated with Weston for almost 20 years.

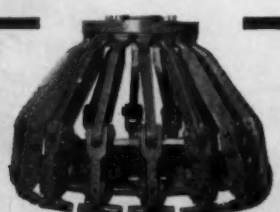
Wentworth

Romell

Vulcan-Cincinnati, Inc. (formerly The Vulcan Copper & Supply Co.) has elected **Paul W. Wentworth** as executive vice president, and **Robert F. Romell** as vice president of the company and general manager of Vulcan Manufacturing division.

Paul Wentworth, a son of the company's founder, H. O. Wentworth, is a graduate of the University of Cincinnati and has actively been associated with the firm since 1928.

Robert Romell has been associated with Vulcan since 1940. Previously he held the position of manager of Vulcan Manufacturing division. He is a native of Cincinnati and a graduate of Yale University. He has also filled various other engineer-



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ing positions during his career with Vulcan-Cincinnati, Inc.

Also announced was that **L. Calvin Palmer** has been appointed chief project engineer of Vulcan Engineering division. Palmer joins Vulcan after having been associated with Allied Chemical and Dye Corp. at Baltimore. For the past five years, he was director of engineering in charge of all engineering and construction for Mutual Chemical division of Allied Chemical and Dye.

Emery Industries, Inc. has appointed **George R. Williams** sales representative in the New York area.

Williams holds a B.S. degree in physical science from the University of Chicago, and a B.S. degree in chemical engineering from the University of Wisconsin. Prior to joining Emery, he was the Cincinnati area salesman for Merck & Co., Inc.

Delta Tank Manufacturing Co. has established a new oil field equipment sales and stocking point in Houston. Delta operates other oil field equipment sales and stocking offices in Baton Rouge, Westwego, Lafayette and Bossier City, La., and in Laurel, Miss.

Boston Woven Hose & Rubber Co. has appointed **Randolph H. Jackson** as director of sales. Jackson will direct all sales activities of Boston Co.'s Industrial Rubber Products division.

Prior to joining the Boston Co., Jackson was vice president of the Clinch-Tite division of Payson & Trask, and previously was manager of the Power Transmission division of the American Pulley Co.

Hills-McCanna Company, Chicago, has appointed **P. R. McCloud** as product sales manager and **H. P. Orlebeke** as chief engineer, both of the Pump Sales department.

McCloud has been with sales organization of Hills-McCanna since November, 1955, and was previously with the Fansteel Metallurgical Corp. as Milwaukee district manager.

Orlebeke has been with the engineering and sales organization of Hills-McCanna for five years and has had previous engineering experience with Standard Oil Co. (Indiana) and Union Carbide and Carbon.

Laclede-Christy Co. Division, H. K. Porter Company, Inc., has appointed **Melvin A. Young** as administrative assistant. Young will work on specific problems in production and engineering at Laclede-Christy.

Young graduated from the United States Military Academy in 1952. Prior to this, he attended Washington University, St. Louis, Mo., receiving a B.S. degree. He also attended the graduate school of Washington University school of business administration.

Koppers Co., Inc., President **Fred C. Foy** has been elected to the board of directors, **H. K. Porter Co., Inc.** Foy joined Koppers in 1948, became a director in 1954 and was elected president in 1955. Before joining Koppers he was vice president and manager of the Detroit office of J. Walter Thompson Co.

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And "Ye Very Beste" in rust protection for iron and steel items from nuts and bolts to H-beams is *hot-dip galvanizing* by the Nowery J. Smith Co., the South's largest commercial galvanizing company.

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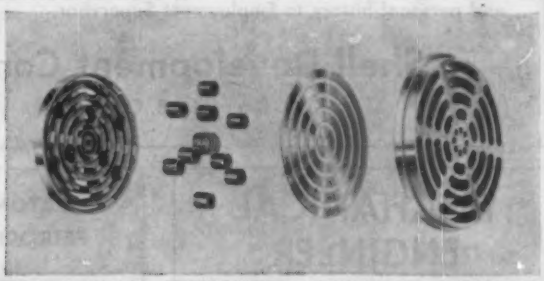
one of the SMITH INDUSTRIES serving the Southwest

Commercial Galvanizing

8000 Hempstead Hwy. UNderwood 9-1425
P. O. Box 7398 Houston 8, Texas

VOSS VALVES in your machine mean



LESS MAINTENANCE, FEWER SHUTDOWNS for your compressor. (air, gas, ammonia)

- up to 40% more valve area • minimum pressure loss • higher efficiency
- less power consumption • normal discharge temperature
- quiet, vibration-free • utmost safety • lower operating costs

VOSS VALVES are made to specification, machined from solid stock (not cast) — VALVES and PLATES are of heat-treated alloy or stainless steel; PLATES are machined, not stamped, and ground for precise close-tolerance fit; are dimensionally stable . . . ductile . . . resist fracture, high temperatures and corrosion . . . withstand fatigue. SPRINGS, of heavy rectangular sections and large diameters, add to dependability and safety.

Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.

J. H. H. VOSS VALVES REG U.S. PAT. OFF.

J. H. H. VOSS Co., Inc.
785 East 144th Street, New York 54, N. Y.

PETROLEUM REFINER

Classified Ads

Petroleum Refiner New Classified Rates

RATES: Regular Classified (undisplayed) set in this size type: 20 cents per word. Minimum charge, $4. Blind box address in our care counts six words. Replies forwarded without charge. **Display Classified ads,** set in suitably larger type with ruled border, $12.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All Classified ads payable in advance.** Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

* * * * * * * * * * * * * * * * *

HELP WANTED

CHEMICAL ENGINEERS
PROCESS ENGINEERING

Young men with advanced degrees in chemical engineering or at least three years' experience in process design of oil refining or chemical manufacturing facilities. Opportunities directly concerned with evaluation of research projects in the petroleum and chemical fields and design of new process units for Shell Oil Company and Shell Chemical Corporation. Located in the San Francisco Bay Area. Write giving education, experience, and personal history to Employment Supervisor.

Shell Development Company
Emeryville 8, California

MECHANICAL ENGINEER

Excellent opportunity in the rapidly expanding petrochemical industry—permanent career position in our Engineering Department.

A mechanical engineer with 5-10 years experience, preferably, but not necessarily in utilities, would be suitable. Emphasis on design of installations for steam generation, steam distributing systems, pumps for various services, turbine drives and cooling towers. All phases of mechanical engineering are used in the above work.

Send resume of experience and salary requirements to:

Manager,
Technical Recruiting
MONSANTO CHEMICAL COMPANY
P. O. Box 1311
TEXAS CITY, TEXAS

BATON ROUGE, LA.
PETROCHEMICAL PLANT
Needs
Chemical Engineers
and
Mechanical Engineers

Rapidly growing & well integrated company needs Engineers interested in Design, Operations, & Maintenance work. Send education & experience resume to:

CHARLES C. BREWER
Foster Grant Co., Inc.
Drawer 2870, Baton Rouge, La.

REFINER
Classified Ads Bring
RESULTS

HELP WANTED

Chemical
and
Mechanical

ENGINEERS

Large expanding international petroleum company seeks the services of several Chemical and Mechanical Engineers for assignment New York area and eventual Far East career. Minimum 3 to 5 years experience. Petroleum background or allied industry preferred. Maximum age 40. Will pay moving and transportation expense and provide temporary living allowance. Salary commensurate with experience. Liberal retirement, savings, insurance and health plans offered. Replies held in confidence. Forward resumes D. V. Ward.

Standard-Vacuum Oil Company
P. O. Box 1000, White Plains, New York

ENGINEERS

Heat Exchangers
Pressure Vessels

Men with refinery or chemical plant experience who are familiar with process design and estimating of heat exchangers and fractionation columns. Responsible positions with an outstanding manufacturer. Good salaries. Profit-sharing retirement plan. Allowance for moving to Southern California. Send a summary of your experience and interests to F B Stratford, Head of Personnel, C F BRAUN & CO, Alhambra, California.

HELP WANTED

CHEMISTS
CHEMICAL ENGINEERS
WORK IN HOUSTON

Expanding Oilfield Service Company has openings for chemists and chemical engineers for positions in Research Department. Work would involve new product development as well as application and evaluation of new developments.

This is a chance to progress with a well established oilfield service company. Opportunity for advancement based upon ability. Benefit programs include hospitalization, life insurance, liberal retirement program, and profit sharing. Send complete resume to **Box 256-R, Petroleum Refiner, Houston, Texas.**

HEAT TRANSFER ENGINEER

Young man 28 to 35 years capable of design, rating and sales of heat exchangers. Established fabricator located in S.W. City of 300,000.

Reply stating full particulars as to education, employment background and qualifications.

Salary commensurate with experience and ability.

All replies confidential. Reply to Box 257-R, PETROLEUM REFINER, Houston, Texas.

JOB OPPORTUNITY

Engineer with 5 or more years experience in Refinery Operation. Position in Development Department making economic studies of existing and proposed Refinery and Petro-Chemical Operations. Southern location—Salary Open. Write Box 252-R Petroleum Refiner Houston, Texas.

FOR SALE

NEW 40-TRAY
ASME CODE VESSEL

FABRICATED 1956—NEVER INSTALLED

5'-6" Diameter • 87'-0" Tangent

A-285-C-FBQ Steel

Max. working pressure 267 PSI at 650° F.

AVAILABLE FOR IMMEDIATE SHIPMENT

The FLUOR CORPORATION, Ltd.
P. O. Box 7030, East L.A. Branch
Los Angeles 22, California
Write R. M. Savage Phone: ANgelus 2-6111

ENGINEERS

Process

Assignments in our Process Engineering Department for engineers with three to six years experience range from integrated refineries and chemical plants through all types of individual process units. The work includes heat and material balance, and computations for unit operations such as fractionation and heat-transfer. Send a summary of your experience and interests to F B Stratford, Head of Personnel, C F BRAUN & CO, Alhambra, California.

Free to
PETROLEUM REFINER Subscribers

Write for free booklet on preparation of articles for PETROLEUM REFINER, the technical press generally, as well as papers for technical meetings. Use Reader's Service green cards in the back of this issue. Write on the card "Free Author's Booklet," fill in name, address and mail. No charge, no obligation.

HELP WANTED

ENGINEERS

Chemical
Mechanical
Petroleum

Assignments in our Chemical Engineering Department cover application of processes to a wide variety of industrial plants, complete integrated refineries and chemical processing centers. The work includes coordinating of chemical engineering, selection and design of process equipment and startup of completed plants. Send a summary of your experience and interests to F B Stratford, Head of Personnel, C F BRAUN & CO, Alhambra, California.

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Handle more cars better—cost less to install and maintain. Foster stocks all Rail Sections 12# thru 175#, Switch Material and Track Accessories.
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Technical Positions Available

1. Electrical Engineer. Several years design 10,200
2. Mechanical Engineer. Research and development 10,000
3. Sales Engineer. Metallurgical background 9,600
4. Chemical Engineer. 2 or 3 years processing 8,400

Many other positions available locally and abroad.
Many companies pay our fees on technical jobs.

DIXIE EMPLOYMENT SERVICE
505 South Coast Bldg., HOUSTON
CA 2-9537

CLASSIFIED ADS

HELP WANTED

ENGINEERS

Process

Assignments in our Process Engineering Department for engineers with eight or more years of experience cover process design, selection of processing steps, and economic evaluation of processes. Other work may include market analysis, industrial surveys, and technical assistance to sales. Send a summary of your experience and interests to F B Stratford, Head of Personnel, C F BRAUN & CO, Alhambra, California.

HELP WANTED

PROCESS ENGINEERS

- ***Design***
- ***Instrumentation***
- ***Development***
  (methods and data)

CAREER OPPORTUNITIES IN

SOUTHERN CALIFORNIA

•

for men with a minimum of five years' experience in PROCESS DESIGN for Petroleum or Chemical plants.

•

OFFERING MAXIMUM OPPORTUNITIES FOR:

Utilization & recognition of individual initiative & ability.

Broad responsibilities rather than narrow specialization.

Experience with a wide range of processes.

•

LIBERAL SALARY RANGES, PROFIT SHARING, TOP BENEFITS, & IDEAL WORKING CONDITIONS

Submit resume of training & experience to:

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FLUOR CORP. LTD.
ENGINEERS-CONSTRUCTORS
2500 S. Atlantic Blvd.
Los Angeles 22, Calif.

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Need Engineers - Technical Personnel? Try a Classified Ad in Petroleum REFINER.

QUICK!
ECONOMICAL!
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Help Wanted! Classified Ads in Petroleum REFINER get the job done.

ATTENTION EQUIPMENT MANUFACTURERS!

Manufacturers representative desires new lines. Now calling on Refineries, Process Plants and related accounts. Will consider outstanding line of process or production equipment.

Warehousing available. Contact:

ALFORD ENGINEERING AND EQUIPMENT CO.
102 East 26th Houston 8, Texas

REFINERY ENGINEER—Process engineering position with large independent company operating in Mid-Continent area. One to five years experience desired. State qualifications and give salary requirements. Box 255-R, PETROLEUM REFINER, Houston, Texas.

Sales Engineer

Manufacturers representative requires young chemical or mechanical engineer with process experience to sell process equipment to Gulf Coast Refineries and chemical plants. Participate substantially in steady growth of small company. Replies confidential. Give short resume for interview.

THE RAINEY COMPANY
P. O. BOX 6453, HOUSTON 6, TEXAS

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Write for free booklet on preparation of articles for PETROLEUM REFINER, the technical press generally, as well as papers for technical meetings. Use Readers' Service green cards in the back of this issue. Write on the card "Free Author's Booklet," fill in name, address and mail. No charge, no obligation.

Send for your **FREE** copy of the **New Petroleum Books Catalog** containing descriptions of many books pertaining to the Petroleum Industry. Send your request to **Book Department, Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas.**

Suppliers . . .

Fischer & Porter Co. has opened a sales office in Indianapolis, Ind. The new office will cover all territory in Indiana except counties in the northwest. **William Morgan,** who formerly headed F&P's Milwaukee office will be Indianapolis district manager.

Jones & Laughlin Supply Division has announced that **Duane C. Wixson,** sales representative who has served at Hill City, Okla., the past three and a half years, has been assigned to the Russell area; and **Verlyn I. Ginther** has been promoted from local store manager to sales representative at Hill City.

Wixson joined J&L Supply's store force at Chase, Okla., on July 1, 1947, and served as storeman until July, 1953, when he was promoted to sales representative at Hill City.

Ginther has been associated with firm's oilfield supply store at Hill City since his employment in March, 1952, as a storeman. He was made local store manager at that location on April 1, 1956.

United States Steel Corp. has announced that **David F. Austin,** executive vice president, has retired after nearly 39 years of service. Austin's successor is **Richard F. Sentner.**

Austin began his career with United States Steel in 1918 in the New York office. After several sales assignments, he served as manager in three district sales offices, and in 1938 was elected vice president in charge of sales of the Carnegie-Illinois Steel Corp. He was elected vice president of the United States Steel Corp. of Delaware in 1945, and in 1951, became executive vice president-commercial of United States Steel Co.

Sentner joined the United States Steel Corp. of Delaware in January, 1948, as assistant vice president-sales. With the formation of the United States Steel Co. in 1951, Sentner became assistant executive vice president-commercial, and in January, 1953, when the United States Steel Corp. became an operating concern, he retained that position.

Clyde Tube Forgings, Ltd., has appointed **A. H. Simpson,** London sales manager. He was export sales manager of Foamite Ltd., from 1947 until taking up his present appointment. Simpson will be located at the London Office of Shaw-Petrie, Ltd./Clyde Tube Forgings Ltd., 157 Victoria Street, S. W. 1.

Air Reduction Sales Co. has announced that three regional vice presidents have been named to administer field activities pertaining to production, distribution and sales.

A. C. Brown, Jr., general sales manager, was named vice president-eastern region with offices in New York; **D. D. Spoor,** equipment sales manager, New York, has been appointed vice president-midwestern region and will be located in Chicago; and **J. J. Lincoln, Jr.,** vice president, New York, will become vice president-southern region with headquarters in Houston.

Air Reduction Sales Co., is a division of Air Reduction Co., Inc.

JACK B. RINCKHOFF (right), Chief Engineer, Sulphuric Acid & Phosphates Dept., Chemical Construction Corp., N. Y. City. Left, Michael De Piano, New York Cooper Alloy Representative.

RINCKHOFF OF CHEMICAL CONSTRUCTION

answers 3 questions on Cooper Alloy Valves

Q. Mr. Rinckhoff, in specifying equipment for the H_2SO_4 plants that Chemico constructs around the world, what Cooper Alloy valve models do you buy most of?

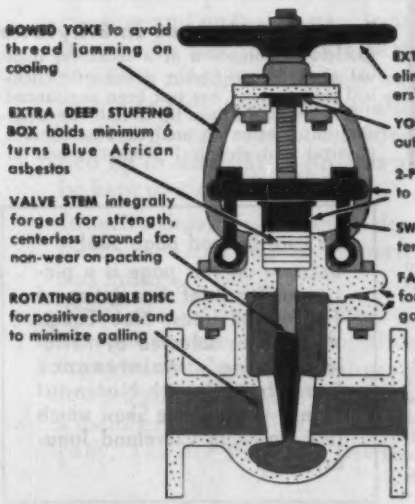
A. Over 80%, I'd say, are OS&Y type gate valves, in sizes 1"to 8"

Q. What's your most important reason for buying Cooper Alloy valves?

A. Availability. Your chain of distributors across the country and in remote parts of the world is of great importance to us. In foreign construction we have often specified Cooper Alloy because of this all-important availability.

Q. What about design and quality?

A. Vital. Valve design determines performance, and our specifications are rigid. As a construction company, we can't afford to jeopardize our reputation by installing questionable equipment. Cooper Alloy valves have passed our tough specs, and have my approval for all severe construction applications.


BOWED YOKE to avoid thread jamming on cooling
EXTRA DEEP STUFFING BOX holds minimum 6 turns Blue African asbestos
VALVE STEM integrally forged for strength, centerless ground for non-wear on packing
ROTATING DOUBLE DISC for positive closure, and to minimize galling
EXTRA LARGE HANDWHEEL to eliminate need for "persuaders"
YOKE NUT REPLACEABLE without valve disassembly
2-PC. GLAND CONSTRUCTION to prevent scoring of stem
SWINGING EYEBOLTS for maintenance convenience
FAIRED BODY-BONNET FLANGES for equal stress and uniform gasket loading

A VALVE DESIGNED FOR STAINLESS!

The Cooper Alloy valve is not an adaptation of earlier brass and iron patterns. Cooper Alloy, with over 35 years of experience in handling stainless steel, created a valve *designed to be cast in stainless!* **Check the Special Design Features shown at left.**

As the little CA man below is saying: *"You can tell a Cooper Alloy Valve as far as you can see it!"* Write today for *your* copy of our folder "Design Factors In Stainless Steel Valves." The Cooper Alloy distributor near you will be glad to show you the complete line of Cooper Alloy valves *and fittings*, and their advantages. He can serve you promptly from local stocks.

COOPER ALLOY

Corporation • Hillside, New Jersey

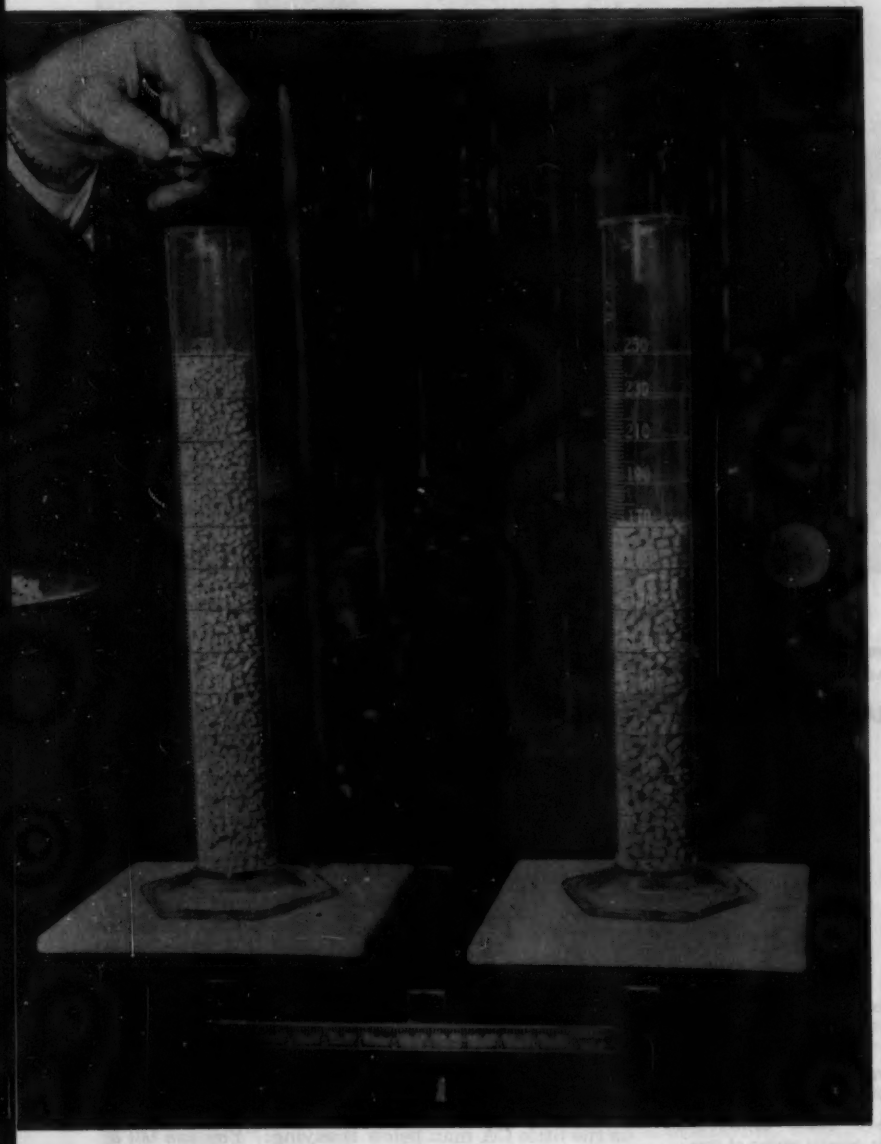
VALVE & FITTING DIVISION

THIRTY-FIVE YEARS OF STAINLESS STEEL PIONEERING

For more data on advertised products, use Readers' Service Cards, last page.

What's New in Equipment . . .

. . . and Manufacturers Literature



Same Amount of Catalyst Treats More Stock

The development of another new petroleum-refining catalyst for the removal of sulfur from hydrocarbons has just been announced.

The new product, a cobalt-molybdena catalyst called Aero HDS, reduces the sulfur content of petroleum fractions by conversion to hydrogen sulfide. The catalyst has high volume activity and excellent mechanical properties.

Refiners utilizing the new product can expert longer on-stream service life due to slower blocking of internal working surfaces, laboratory test reports indicate. Higher active metals content, superior porosity and low bulk density are also cited as significant improvements over existing compounds.

The latter feature makes it possible to use fewer pounds of catalyst to fill a given volume of reactor space while maintaining a high activity level. Refiners now have a choice between treating the same amount of stock with fewer pounds of catalyst or considerably more stock with the same quantity of catalyst.

Actual plant experience with Aero HDS shows that at 80 percent removal, 40 percent more naphtha can be treated over a given weight of catalyst. Or, a refiner can treat a given base amount of naphtha with up to 30 percent less catalyst.

Nitrogen removal efficiency has also been evaluated on a relative basis. Resulting data shows Aero HDS to be more effective than existing catalytic compounds.

Designed for service in both new and existing facilities, the product also lends itself to regeneration during use. Preliminary tests on a laboratory scale, using air under closely controlled temperature conditions, indicate that catalyst activity is not adversely affected by regeneration, while mechanical properties are only slightly influenced. American Cyanamid Co. **Circle E1 green card, last page**

Rotameter Measures By-pass Flow—The new by-pass Rotameter is designed to permit economical measurement of large fluid flow rates in pipe sizes of 2 inches and above. It utilizes most of the inherent advantages of the Rotameter such as: linear response, wide range (up to 10 to 1), direct reading scale, and ability to handle corrosive fluids. Among its many advantages is the elimination of overload checks, seal pots, and equalizing valves. Brooks Rotameter Co.

Circle E2 green card, last page

Spring Production—A new 16 page bulletin describes the companies adaption of automation techniques in producing springs, and contains formulas and specifications for helical extension springs and volute and Belleville disc springs. Also included in the book are two pages of design recommendations and a chart listing physical properties for calculating springs in 22 materials. ALCO Products, Inc.

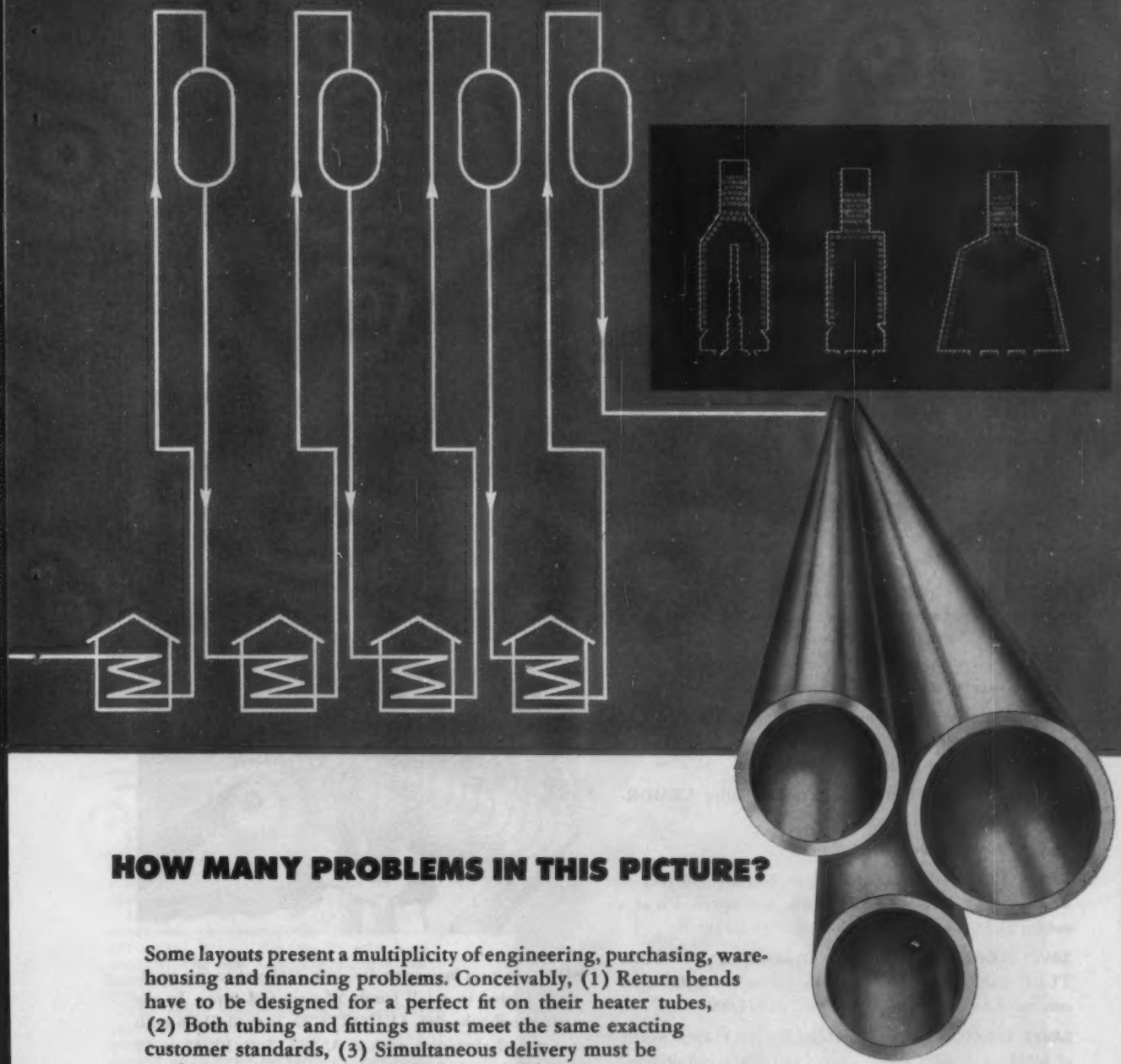
Circle E3 green card, last page

Technical Manual on Ethylene Oxide—Publication of a technical manual on Ethylene Oxide, a versatile chemical intermediate, has just been announced.

The manual brings up to date the available information on analytical procedures, physical and chemical properties and in-

Be sure to read page 306!

Because on this page is a picture and a brief description of five of the latest New Equipment items selected by Petroleum Refiner's Maintenance Editor from the 8th National Plant Maintenance Show which just closed in Cleveland January 31.



HOW MANY PROBLEMS IN THIS PICTURE?

Some layouts present a multiplicity of engineering, purchasing, warehousing and financing problems. Conceivably, (1) Return bends have to be designed for a perfect fit on their heater tubes, (2) Both tubing and fittings must meet the same exacting customer standards, (3) Simultaneous delivery must be made to guarantee erection schedules, and (4) Money tied up in material in process at any one time must be kept to a minimum.

In such a situation, it's best to depend upon Mr. Tubes for coordinated delivery of perfectly matched tubing and fittings.

Think of your own requirements in terms of the right tube for the job, tubing (or alloy pipe) and welding fittings and forged steel flanges as components of an integrated system—and you'll make B&W's Mr. Tubes a member of your team. The Babcock &Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

B&W TUBULAR PRODUCTS DIVISION

TA-6085-PP

Seamless and welded tubular products, seamless welding fittings and forged steel flanges in carbon, alloy and stainless steels

THIS IS BAILEY ARMORTUBE CABLE

every foot you install saves you $5 to $6

ARMORTUBE Cable consists of multiple copper or aluminum tubes in a single, flexible armored cable. You string *one* line. You buy *one* set of standard pipe supports or conduit clips. You make a neater, protected installation. Installation costs are reduced tremendously.

Users of copper or aluminum tubing for connecting pneumatic instrument and control lines report that it costs about $2.00 a foot to install single tubes.

It costs the same $2.00 a foot to install Bailey ARMORTUBE Cable.

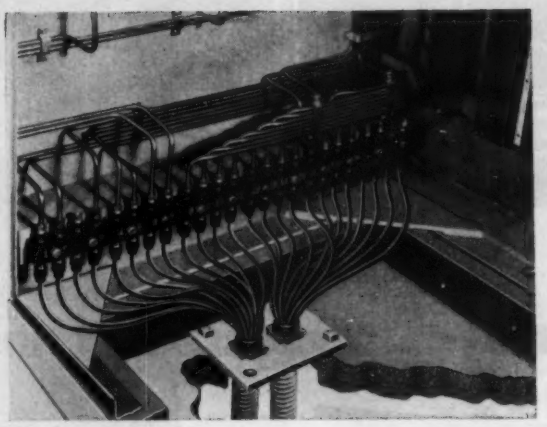
But here's what customers tell us . . .

SAVES $3,000—A chemical plant bought 530 feet of 4-tube Bailey ARMORTUBE Cable and installed it at a saving of $3,000 over the cost of four single tubes.

SAVES $14,000—Another chemical plant bought ARMORTUBE Cable costing $1,345. The saving on installation compared to single tubes amounted to $14,000.

SAVES $60,000—An electric utility bought $14,068 worth of ARMORTUBE Cable . . . saved $60,000 on installation.

Whether your next job consists of 100 or 100,000 feet of tubing, it will surely pay you to check on savings possible with Bailey ARMORTUBE Cable. For more information ask for Product Specification and Price List G91-9.



NOW—to meet increasing demands, this cost-saving product is offered in a full family of sizes and types. In the quarter-inch tube size, ARMORTUBE is available in both copper and aluminum with 2, 3, 4, 5, 7, 8, 10, 12 or 19 tubes. Tubes are protected with galvanized steel armor or a combination of steel armor and thermoplastic . . . with thermoplastic sheath located either over or under the steel. Other sizes are copper tubes in steel armor only: ⅜″ in bundles of 1, 2, 3, 4, 7; ½″ in bundles of 1, 2, 3, 4. G-38

Instruments and controls for power and process

BAILEY METER COMPANY

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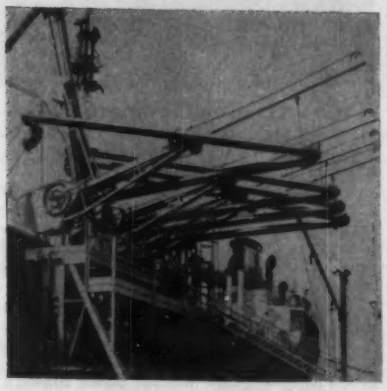
In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

dustrial uses. Data is included on handling techniques, and toxicity, as well as specifications on commercial grades. The information is documented in a bibliography listing almost 500 references.

Ethylene Oxide has long been a valuable reagent in the laboratory preparation of synthetic organic compounds. New catalytic methods of manufacture from petroleum fractions have launched Ethylene Oxide into bulk use as an essential intermediate in the commercial production of ethylene glycol, and other glycols, for antifreeze, humificants, and the manufacture of resins and plastics. Other polyoxyethylated derivatives find use as surfactants in stabilizers, detergents, emulsifiers and wetting agents. Jefferson Chemical Company, Inc.

Circle E4 green card, last page



Improved Ship Loading—Hailed as the first basic improvement for loading and unloading of liquids in 30 years, the new Marine Loading Arm has just passed its first half-year of service with flying colors.

Completely mechanized, these hydraulically powered Loading Arms are easily swung into hook-up position aboard a vessel or returned to their rack by one man operating simple lever-type controls.

Impressive are the savings in maintenance due to the superior resistance of all-metal loading arms to wear and weather. The new loading equipment can handle liquids ranging from 60 F. to 225 F.

The entire apparatus can be handled, positioned and stored by the movement of simple control levers. Once the arm is flanged up, it needs no further attendance. Free-wheeling feature allows arm to ride with rise and fall of the vessel as well as any inboard and outboard movement.

A simplified control panel facilitates the loading hook-up and a hydraulically controlled selector valve makes possible the operation of any of a number of arms. Travel movement is controlled by three plainly marked levers. Chiksan Co.

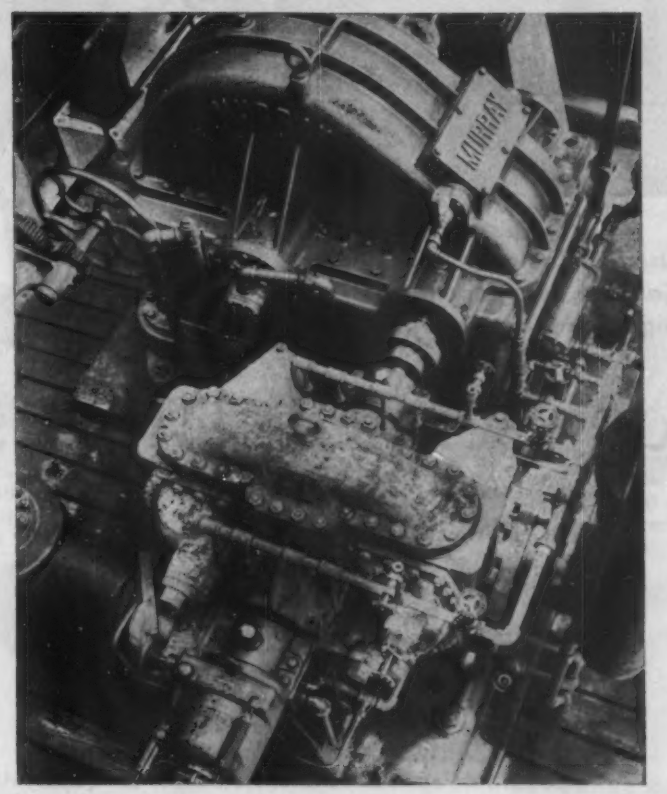
Circle E5 green card, last page

Valve Guide Book—A newly revised edition of the valuable reference work, "Guide for Selecting Valves, Boiler Mountings, Lubricating Devices" has just been published.

New sections, describing revolutionary

Murray Turbines

OUTDOOR INSTALLATION?



THE RIGHT ANSWER—MURRAY

The turbo-gear unit shown above has been installed outdoors with virtually no weather protection for many years. The turbine exhausts to a process line carrying 170 psig pressure. Yes—for rugged applications—the right answer—MURRAY.

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

For more data on advertised products, use Readers' Service Cards, last page.

Use this "refinery special" Castable Refractory with very high abrasion resistance for —

Long service–low cost

Tests by users and in Laclede laboratories show that Laclede Firmcast Castable Refractory delivers exceptional long-life and economy – in 90% of catalytic regenerators, flue gas stacks and ducts, transfer systems and separators. Firmcast has two special qualities which contribute to its long life.

Hard and dense aggregates in Firmcast are especially selected, then bonded with sufficient matrix to provide excellent abrasion resistance. Because it is "quality-control" processed, Firmcast uses a minimum amount of water for flow-ability and workability.

Next time specify Firmcast Castable Refractory – produced only by *Laclede-Christy Division, H. K. Porter Company, Inc., St. Louis 10, Missouri.*

HKP LACLEDE-CHRISTY DIVISION
H. K. PORTER COMPANY, INC.

New Equipment . . .

new LQ600 Bronze Globe Valves, with Brinalloy Seats and Discs; Luncor PVC All-Molded Valves, which are completely resistant to industrial chemicals; and the companies Solder End Valves have been added to the 24 pages of tables, technical data and information on the selection of valves, boiler mountings, and lubricating devices. The Lunkenheimer Co.

Circle E6 green card, last page

Hazardous Area Chromatograph— A new automatic vapor-phase chromatograph, designed for use in hazardous areas, has just been introduced.

The instrument consists of two units: (1) The analyzer, designed for use at the sample point in the plant or other similar hazardous location, and (2) the control unit, which may be located as much as 500 feet away.

The instrument makes use of the elution method of vapor-phase chromatography. A fixed sample of gas is introduced into a carrier-gas stream (e.g., helium, hydrogen, nitrogen), and washed down through a chromatograph column by the continuous flow of the carrier gas. Because components in the sample will travel through the column packing at a rate dependent on individual physical properties, each component will emerge from the bottom of the column at a different time. As each component emerges, its concentration in the carrier stream is measured by a thermal conductivity cell and is indicated on a recorder as a peak. Consolidated Electrodynamics Corp.

Circle E7 green card, last page

Welding Fittings—A 28-page catalog-manual on a complete line of Seamless Steel and Alloy Butt Welding Fittings is now available. The data include detailed specifications on both the standard weight and extra strong line of elbows, return bends, straight and reducing tees, concentric and eccentric reducers and caps available in a variety of alloy materials and in sizes from 1 to 24 inches. Shaw-Petrie, Ltd. **Circle E8 green card, last page**

Screwdriver Operates Switch— A new switch that can be installed in limited-access areas and actuated by a screwdriver is now being marketed.

The compact switch is described as especially handy for installation in out-of-the-way places, or where a switch needs to be operated only occasionally, such as when testing circuits.

It can, for example, be installed deep inside of equipment and operated only when desired by inserting a long screw-

For more data on advertised products, use Readers' Service Cards, last page.

New Equipment . . .

driver through an access hole. This can eliminate the cost of mounting a switch on top of a chassis, or on a panel, and can save panel space as well.

Designated the 1RA1, the new switch is a subminiature single-pole double-throw assembly. It has a slotted actuator head, with 90-degree rotation, that gives visual indication of switch position. Its bushing permits one-hole mounting in panels up to 3/32-inch thick. Minneapolis-Honeywell Regulator Co.

Circle E9 green card, last page

Instrument Tube Bundle—A new fire and impact resistant instrument line harness for use in chemical processing and petrochemical plants, refineries, etc., is now announced.

Dekoron Super Poly-Cor is of multiple-tube construction and is light and supple, it can be installed at a small fraction of the cost of single or multiple-line metal instrument tubing. Furthermore, since it is flame retardant and impact resistant, it can be used in hazardous areas where flash fires or welding splatter is a danger; it can also be buried in the ground.

It is composed of a bundle of twelve ¼-inch O.D. linear polyethylene core tubes that withstand all normal instrument line pressures. Over this bundle is extruded an extra heavy thermal and shock barrier covered with braided, fireproof AA asbestos. The whole assembly is then covered with an extruded flame retardant outer sheath. Samuel Moore & Co.

Circle E10 green card, last page

Paint Guards Against Hydrogen Embrittlement—The new marking material tells-the-tale on hydrogen embrittlement hazard on every part. This new "time-and-temperature" indicating paint was developed for application to heat treated parts that have been electroplated, pickled or phosphate treated to permit visible proof that each part has been baked to relieve hydrogen embrittlement.

Tempa-Dot appears as a vivid red dot

Pictures tell why PETROCHEM does MORE than fight fire

IT'S RUGGED . . . stands up to abrasion, resists weather. PETROCHEM'S oil-resistant Neoprene tube is enclosed in a tough, wear-defying Dacron* jacket. It's a rugged, light, flexible fire hose that wears and wears.

*Reg. T.M. E.I. Dupont de Nemours & Co.

IT'S STRONG . . . strong enough to withstand 500 lbs. pressure and 300°F. temperature.

IT'S OIL AND CHEMICAL RESISTANT . . . fights off deterioration both inside and out.

IT'S FLEXIBLE . . . so flexible it takes tight twists without injury.

IT'S EASILY COILED . . . requires a minimum of storage space.

These are the reasons why it will pay you to consider PETROCHEM fire hose in your safety planning. Your Quaker-Quaker Pioneer distributor provides extra-fast service. See him today. For more information, please write to: *H. K. Porter Company, Inc., Quaker Rubber Division, Philadelphia 24, Pa., or Quaker Pioneer Rubber Division, Pittsburg, Calif.*

HKP

QUAKER RUBBER DIVISION
QUAKER PIONEER RUBBER DIVISION
H. K. PORTER COMPANY, INC.

For more data on advertised products, use Readers' Service Cards, last page.

CRESCENT
IMPROVED CABLED TUBING

for use with INSTRUMENTS and PROCESS CONTROL EQUIPMENT

12, ¼" O.D. Tubes, Type CA

CRESCENT ARMORED MULTITUBE

Carries Air, Gas or Fluid

CRESCENT ARMORED MULTITUBE* is a group of from 2 to 37, ¼", ⅜", and ½" O.D. copper, aluminum, steel or polyethylene tubes *spirally cabled* together to permit bending without distortion. These tubes are completely protected from injury during and after installation by a flexible, interlocked, galvanized steel armor. One tube in each layer is a bright blue color, which makes identification of any tube an easy matter.

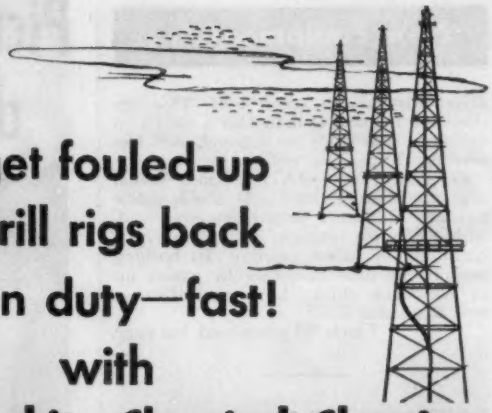
You can show substantial savings on installed cost on moderate to long runs with complete dependability through the use of CRESCENT ARMORED MULTITUBE. It is furnished in continuous lengths up to 1000 feet, thus saving waste and short ends. Corrosion resistant constructions are also available. This product is licensed under U. S. Patent 2,578,280.

* Registered Trade Mark

Tubes furnished in Copper, Aluminum, Steel, Polyethylene—Also special construction for underground runs.

Send for Bulletin 356-G

CRESCENT
INSULATED WIRE & CABLE CO.
TRENTON, NEW JERSEY



get fouled-up drill rigs back on duty—fast! with Oakite Chemical Cleaning

Take, for instance, a bottom-hole pump brought in from the field for replacement . . . outside mucked up, insides choked with gyp.

Useless? Not if you know Oakite. A half-hour at most, and this pump can go back to work! Here's how.

A short soak in a recommended Oakite degreasing solution (Oakite 19 or 24, depending on soil), followed by pressure rinse, and everything comes off the outside. Grease, oil, paraffin, mud, rust—gone. Next, immerse in a descaling solution of Oakite 32, and now the insides are clean of all accumulated gyp and lime deposits. Rinse, then neutralize by dipping in the Oakite 19 or 24 solution. Finish by rust-proofing pump with Oakite Special Protective Oil . . . and it's ready to go.

This is just one example, out of dozens of reconditioning jobs on field equipment, where Oakite methods give you maintenance cleaning at its fastest and easiest. Call your local Oakite Technical Service Representative, or write for free booklet, "What Petroleum Men Should Know to Simplify Cleaning," to Oakite Products, Inc., 50D Rector Street, New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS · METHODS · SERVICE
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Export Division Cable Address: Oakite

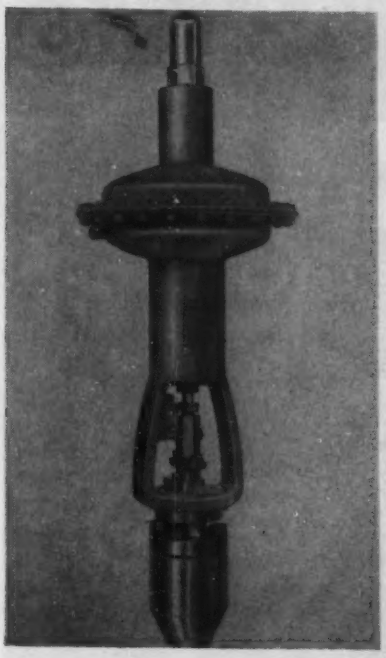
Technical Service Representatives in Principal Cities of U. S. and Canada

New Equipment . . .

before baking and changes color after the proper hydrogen embrittlement bake. Tempa-Dot color reaction is so accurate to tattletale a plus or minus 25° deviation.

Tempa-Dot, which is packaged in half dozen packs at $7.50 half dozen, creates a visible certification on each part and is positive insurance against oversight in hydrogen-embrittlement relief. Everlube Corporation.

Circle E11 green card, last page



Microflo Valve—Spline plugs made of tungsten carbide in twenty-five interchangeable sizes provide predictable flow control in a formerly "impossible" low flow range. Pilot plants and laboratories can now scale down their process to more manageable proportions. Product quality in full scale processes can be improved by the more accurate metering of minute flows.

Microflo Valves with solid Stellite Splines numbered from 1 to 15 provide control of flows from Cv (Max.) = 0.63 (1) to Cv (Max.) = 0.0010 (15). Tungsten Carbide Spline also cover the 1 to 15 ranges and in addition are designed in ten new sizes to include Cv (Max.) = 0.00063 (16) to Cv (Max.) = 0.000010 (25).

These flow coefficient (Cv) values are equal to the rate of flow in GPM of water at full one inch plug lift and at a one psi pressure drop. Since rangeability of every Spline Plug is guaranteed to be at least 50:1, the minimum flow is 1/50 of the maximum Cv's listed above. At a 100 psi pressure drop, for example, the flowrate coverage of the Tungsten Carbide Splines would range from 23,850 cc's per minute (1 Max.) down to 0.0075 cc's per minute (25 Min.).

Maximum working pressures of Microflow Valves are 1200 psi at 100 F. in the

W-S Forged Steel Fittings

Now protected with...

new rustproof coating

That attractive color you see on our forged carbon steel fittings is a new synthetic coating that effectively protects the fittings against corrosion in stock and in service. The coating completely covers the fittings—inside and outside, thus protecting threads and sockets, as well as external surfaces.

If you are going to paint your piping system for color coding or other reasons, the new coating serves as an excellent base for paint. No objectionable rust or scale to scour off before painting.

All W-S forged carbon steel fittings, in both screw-end and socket-welding types, are now available with the new blue rustproof coating.

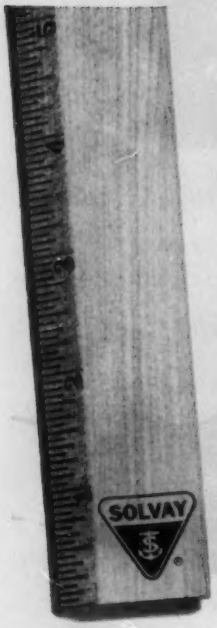
Remember the blue color. It labels the fitting a W-S Quality Product.

Send for your copy of Forged Steel Fittings Catalog A-3-56

Write to W-S Fittings Division, H. K. Porter Company, Inc., P.O. Box 95, Roselle, N. J.

HKP W-S FITTINGS DIVISION
H. K. PORTER COMPANY, INC.

For more data on advertised products, use Readers' Service Cards, last page.



there's no end to the measure of quality, service and dependability you get with

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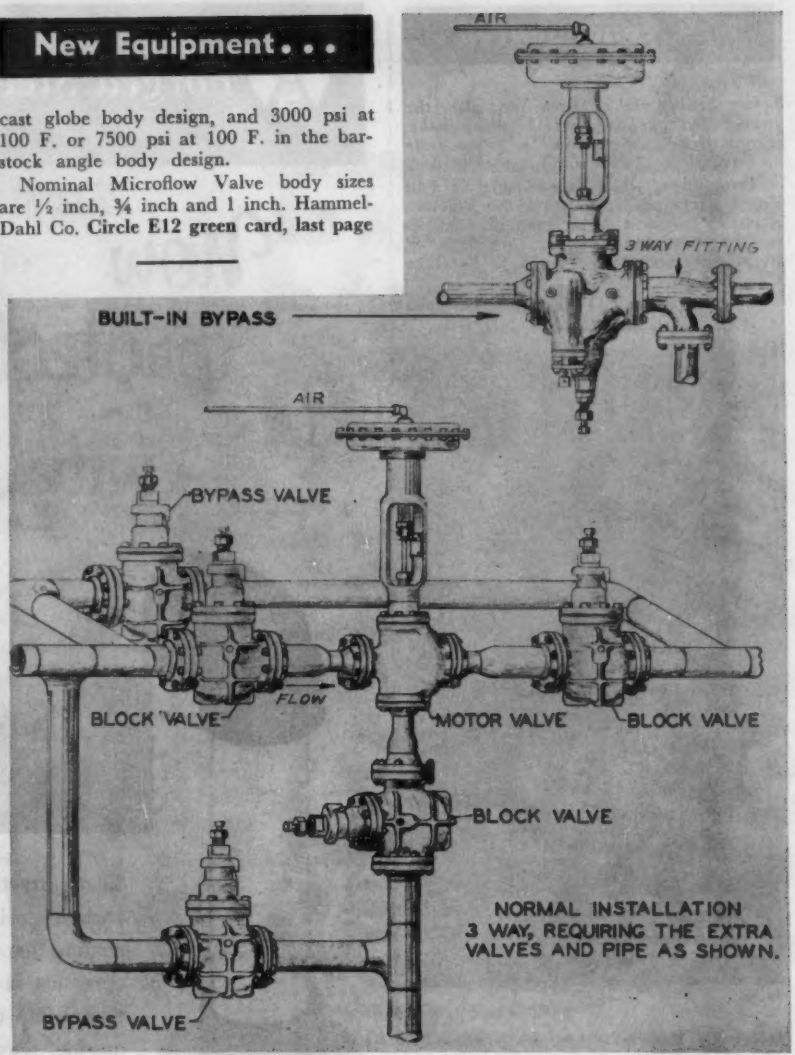
New Equipment . . .

cast globe body design, and 3000 psi at 100 F. or 7500 psi at 100 F. in the barstock angle body design.

Nominal Microflow Valve body sizes are ½ inch, ¾ inch and 1 inch. Hammel-Dahl Co. **Circle E12 green card, last page**



Diaphragm Control Valve Unit—The Control Valve Unit is a new design and invention offered to replace the complete conventional diaphragm control valve installation, either standard or three-way. The standard installation requires a control valve, two block valves, and one by-pass valve, while the three-way installation requires a three-way control valve, three block valves, and two by-pass valves, all with interconnecting piping. The usual arrangement is necessary to allow repair or replacement of the control valve without disrupting the flow stream. The Control Valve Unit combines in one valve body the repair and arrangement principles of the control valve together with stream flow shut-off and by-pass devices. All inner valve parts are interchangeable between the companies diphragm control Valve and the Diaphragm Control Valve unit. The unit is designed so that the repair or replacement of valve seats or change from normally open to normally closed valve position can be accomplished with the valve in the line and operating under pressure. The addition of a three-way fitting and three-way inner valves converts the unit to a three-way installation. Elsey Corporation.

Circle E13 green card, last page

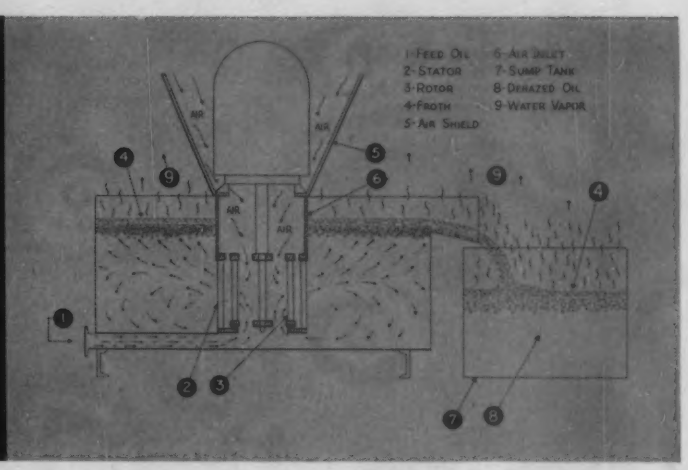
Copper Removal Bulletin—This new bulletin describes the removal of copper and its oxides along with iron oxides and other water-formed deposits, from steam generating units. The bulletin covers theoretical aspects, laboratory data and actual tests on boiler tube samples. Dowell Incorporated.

Circle E14 green card, last page

New Coating For Asphalt Containers—When Leonard Refineries, began packaging asphalt for pipe-covering insulation, in 50-pound cans, they found that the asphalt stuck to its container so tenaciously, it had to be heated to be removed.

Every type of treatment or coating for metal or fiber was tested in an effort to find a better package, but all stumbled

HENDRICK HYDRO-DEHAZER



removes haze from refinery oils in a hurry!

Here's a process that has been operating with a great deal of economy in several major refineries: The Hydro Dehazer's huge rotor mixes moisture-laden oil with free air until the moisture is absorbed by the air and discharged to atmosphere. The entire cycle achieves optimum efficiency without the use of compressed air, high heat, chemicals or other additives. Capacities range to 450 bph for No. 2 fuel oil at an inlet temperature of 130° F. with a haze point of 70° depending on the consistency of the charge. For details or a pilot model demonstration mail coupon today!

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Gentlemen:

I am interested in learning more about the new Hendrick Hydro Dehazer.

☐ Please send technical data.

☐ Please arrange demonstration of the Dehazer Pilot Model.

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Company_____

Street_____

City_____ Zone_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

New Equipment . . .

on the same obstacle. The containers are filled direct from the still when the asphalt temperature is as high as 500 F.—to hot for any organic coating to withstand.

Recently, however, they tried a semi-organic silicone coating: Dow Corning 1107. And they've been using it ever since. Cans are simply fog-coated with a spray gun just before filling. To accelerate curing of the silicone treatment a solution of 1½ grams of lead catalyst in 100 cc of light kerosine is mixed in at the rate of one pint per four pints of 1107. The solution air-dries almost immediately.

The nonstickiness of the resultant coating is such that Leonard's customers now merely slash down the side of the can and strip it away from the cylinder of asphalt.

A single pint of silicone treatment treats 400 to 500 cans. Dow Corning Corp.

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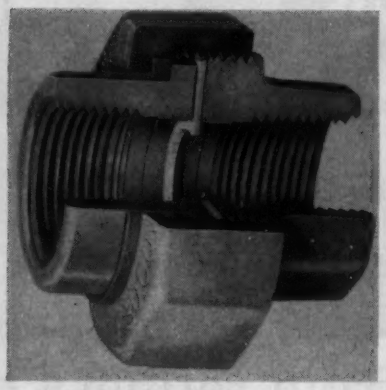
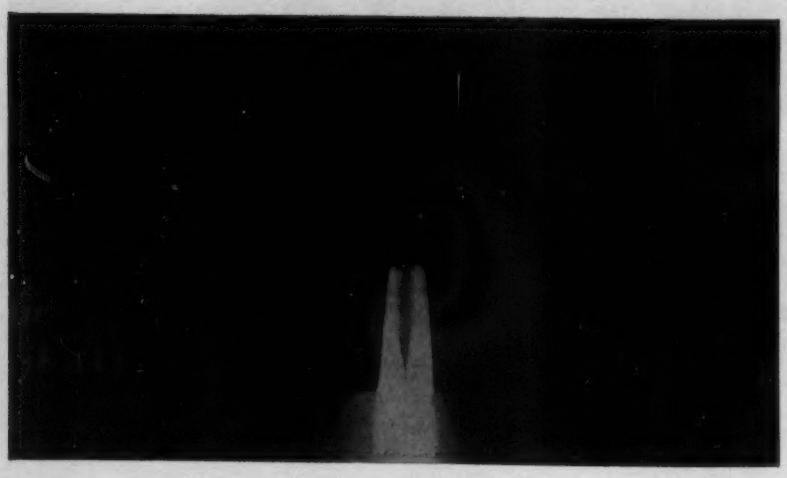


Insulating Union—Insulating forged steel unions, used to prevent electrolytic corrosion due to flow of electric current along pipe lines, are now available. The unions are manufactured in 3000-pound class, sizes ¼ inch to 3 inches in screwend and socket-welding types.

The tailpiece, thread piece and nut are drop forged from carbon steel in accordance with ASTM material specification A-105 Grade 2. The insulating sleeve separating the tail piece and nut is made of fabric-reinforced phenolic resin, noted for its high strength, toughness and chemical resistance. The gasket which seals the union joint, and which is in contact with the fluid in the pipe, is made of Teflon. H. K. Porter Company, Inc.

Circle E16 green card, last page



Welding Equipment Cuts Non-ferrous Plate—The Aircomatic inert gas welding process, developed in 1948, can now be used for cutting non-ferrous metals in addition to welding ferrous and non-ferrous metals.

Aluminum, stainless steel, chrome steel, nickel, Monel, Inconel, copper, brass and aluminum bronze have been cut with a quality entirely satisfactory for subsequent welding operations. On ¼-inch plate, cutting speeds up to 132 inches per minute can be attained on aluminum, and 85 inches per minute on stainless steel. Severence cuts have been made on titanium and magnesium.

The process employs a consumable wire electrode arc in an atmosphere of inert gas such as argon. The inert gas, introduced around the electrode wire, excludes all other atmospheric gases from the im-

Now EVERYONE can get SNAP-ON!

G-B SNAP-ON DISTRIBUTORS

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ALBUQUERQUE, Mt. States Insulation Co.
AMARILLO, Ball Distributing & Engr. Co.
APPLETON, J. D. Wilson Co.
ATLANTA, Ga., Southern States Iron Roofing Co.
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Plant Insulation Co.
LOUISVILLE, General Insulation & Roofing Co.
MADISON, Wis., J. D. Wilson Co.
MEMPHIS, John A. Denie's Sons Co.
MIAMI, Southern States Iron Roofing Co.
MILWAUKEE, J. D. Wilson Co.
MINNEAPOLIS, Asbestos Products, Inc.
MOBILE, Ala., Shook & Fletcher
NASHVILLE, Southern States Iron Roofing Co.
NEWARK, N. J., Eastern Steam Specialty Co.
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NEW ORLEANS, Eagle Asbestos & Packing
NEW YORK, Eastern Steam Specialty Co.
OKLAHOMA CITY, Ball Distributing & Engineering Co.
OMAHA, Cardinal Supply & Mfg. Co.
PHILADELPHIA, John F. Scanlan, Inc.
PITTSBURGH, Dravo Corp.
PHOENIX, Ariz., Kircher Asbestos & Rubber Co.
RALEIGH, N. C., Southern States Iron Roofing Co.
RICHMOND, Va., Southern States Iron Roofing Co.
ROCKFORD, Ill., Mott Brothers Co.
SALT LAKE CITY, Bullough Asbestos Supply Co.
SAN ANTONIO, The Bracken Co.
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SAN FRANCISCO, Western Fibrous Glass Products
SAVANNAH, Ga., Southern States Iron Roofing Co.
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(Advertisement)

EVERYONE can get SNAP*ON!

SNAP*ON . . . THE ONE AND ONLY ONE-PIECE MOLDED PIPE INSULATION OF FINE GLASS FIBERS

Sensational demand has kept Snap*On in short supply ever since its introduction several years ago — but now *everyone* can get Snap*On! To meet the ever-growing demand for this new lightweight insulation that "just snaps on the pipe," we recently made a substantial addition to its production facilities to increase Snap*On production by 150%. These new facilities are turning out the same beautifully uniform one-piece sections that have won such amazing acceptance throughout industry. Here, in a nutshell, is why Snap*On is the *standard specification* in so many industries:

Highest thermal efficiency of any pipe insulating material on the market in its temperature range.

Lower applied cost — just spread the single seam and it snaps on the pipe.

Extremely light weight. . . virtually immune to damage or breakage . . . permanent as glass itself.

So figure Snap*On in all your plans for dual-temperature, cold or heated piping where temperatures do not exceed 350° F. Whether on straight runs, on nested or tracer lines, or at flanges, valves and fittings, Snap*On's flexibility will save you time and money. It's available *now* . . . in sizes from ½" to 33" IPS from your local Snap*On distributor. His name is listed in the column at left. Call him now or—

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GUSTIN-BACON Manufacturing Co *Trademark Reg.

Thermal and acoustical glass fiber insulations • Pipe couplings and fittings • Molded glass fiber pipe insulation

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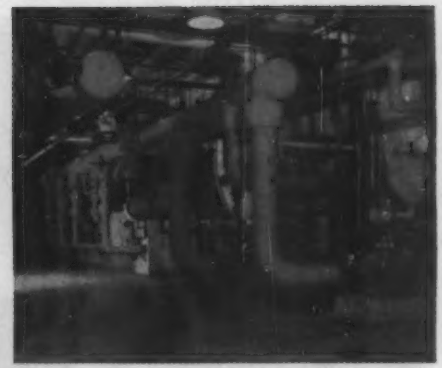
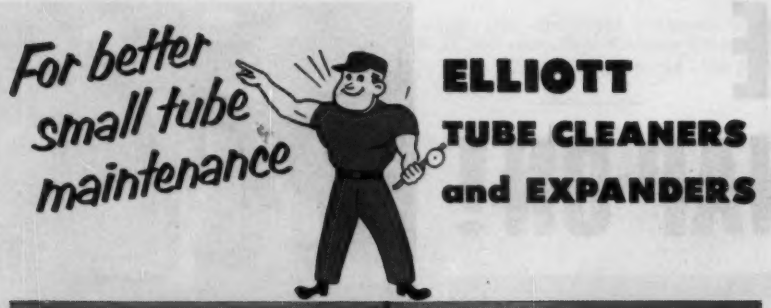


SNAP*ON . . . FOR SERVICES TO 350° F. In wall thicknesses from ¾" to 3" Snap*On is an ideal pipe insulation for industrial processing plants and for commercial and institutional buildings, both from the standpoint of initial cost and long-range heat savings. It is available plain, or canvas jacketed, in sizes from ½" to 33" IPS.

SNAP*ON . . . FOR DUAL-TEMPERATURE AND COLD PIPING. For such service, Snap*On is available with a wide variety of factory-applied jackets that solve every problem involving appearance, vapor resistance and fire resistance. All jacketed Snap*On comes in easy-to-handle, easy-to-apply 3' sections.

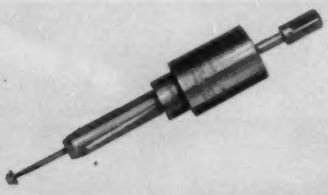
SNAP*ON . . . FOR BIG PIPING, INDOORS OR OUT. Just one easy spread-and-snap motion of the single seam—and 6 feet of 16" pipe is insulated! Fewer seams mean faster application, and far greater thermal efficiency. Plain Snap*On is available in these 6-ft. sections in sizes from 6"-33". For outdoor use, it can also be supplied with factory-adhered weatherproofed jackets.

For more data on advertised products, use Readers' Service Cards, last page.



ELLIOTT TUBE GAGE

Measures inside tube diameters in .001". A quick, guide for setting tube expanders for condenser and heat exchanger tubes. Three point contact of hardened steel balls insures accurate measurements.

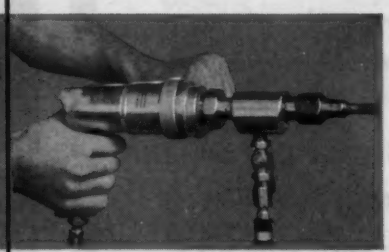


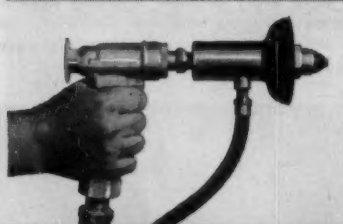
ELLIOTT TUBE EXPANDERS

Roll condenser and heat exchanger tubes quickly and accurately. Rotating, parallel self-feeding rolls insure good joints. For tubes ½ in. through 1½ in., 16 gage.

NEW ELLIOTT 5100 SERIES HEAT EXCHANGER TUBE CLEANER

Powerful air-driven motor with non-rotating, water feeding attachment, trigger-action for motor control, finger-action valve for water flow. Built-in speed governor eliminates shaft-whip. Choice of two sizes.



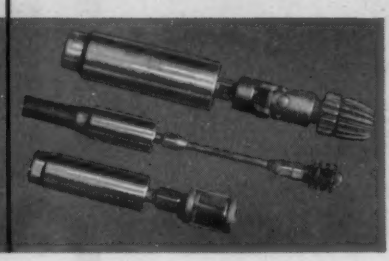


ELLIOTT JIFFY GUN WITH BOOSTER

Combines water and air pressure for extra power and speed, recommended where water pressure is low, or scale deposit is heavy.

ELLIOTT 600 Series Cleaners

For straight and curved small tubes. Air or steam driven motors. Can be equipped with expanding brushes and scraper heads.



YS-10

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Address Elliott Company, Lagonda Division, Springfield, Ohio

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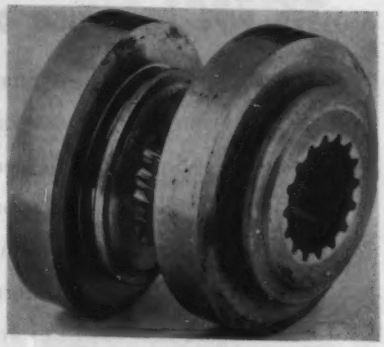
New Equipment . . .

mediate area surrounding the electric arc and weld puddle. This prevents contamination of the weld by these other gases.

In welding, the arc is maintained between the tip or end of the wire and the upper surface of the plate; while in cutting, the arc is maintained between the leading edge of the wire and the leading edge of the cut extending throughout the full depth of the cut. Air Reduction Sales Co. **Circle E17 green card, last page**

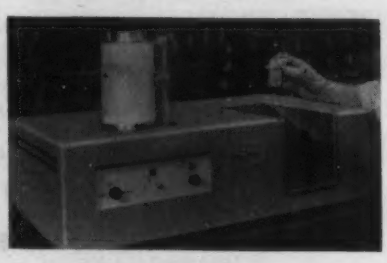


Cemented Oxide Cutting Tools—Surface finish is consistently better with ceramic tools than with carbides used previously. Sliding gear, left, was machined with cemented oxide 0-30 cutting tools at 1000 fpm, while carbide was employed for the other gear at 450 fpm. Gears are previously rough machined on an 8-inch, 8-spindle Bullard Multimatic with conventional tools. General Electric Co.

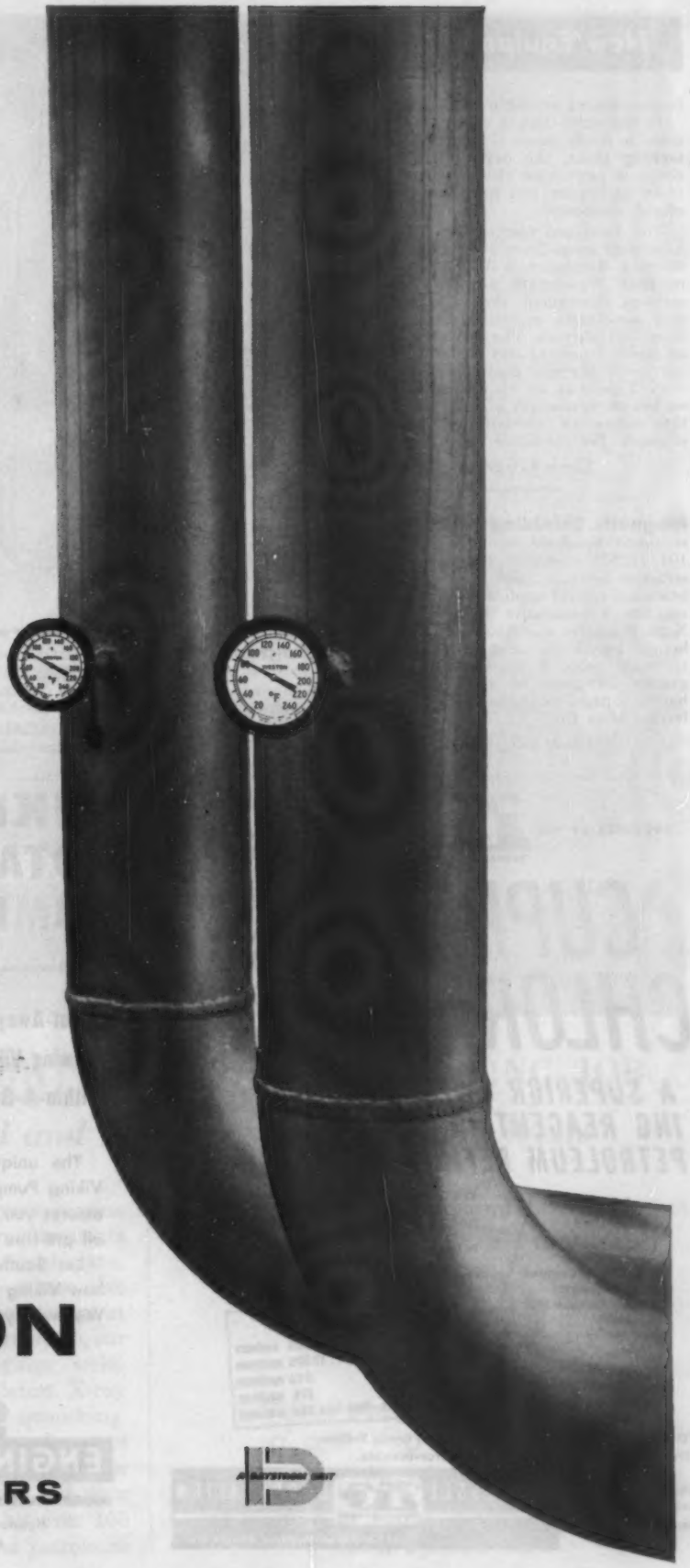
Circle E18 green card, last page

Save It With Neoprene—A new liquid neoprene product can be used as a maintenance coating for any metal part of an automobile to prevent rust, corrosion and inhibit oxidizing action. Simply brushed on any clean surface, it is elastic enough to give and take with the spring action of the body of the car. Convertible tops or any canvas or fabric material can be safely patched or weatherproofed with this liquid neoprene. From the latest issue of neoprene notebook. E. I. du Pont de Nemours & Co. Inc.

Circle E19 green card, last page



Spectrophotometer Gives Fast Analysis—Having completed a 15 minute run, the chemist prepares to insert the next sample in the new Infracord spectrophotometer photograph above. The spectrum is automatically recorded on 8½ x 11 notebook size paper. The Infracord is the first low cost, double beam infrared spec-



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Weston bimetal thermometers are available in types, sizes and ranges for industrial as well as laboratory needs. Bulletin T13 gladly sent on request. Weston Electrical Instrument Corporation, Newark 5, New Jersey.

WESTON
Bimetal
THERMOMETERS

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New Equipment . . .

trophotometer available to the chemist.

In less time than is necessary to determine a single physical property such as melting point, the organic chemist can obtain a permanent record giving a complete qualitative and quantitative picture of the compound.

The Infracord spectrophotometer scans a spectral range from 2.5 microns to 15.0 microns. Resolution is 0.05 microns at 10 microns. Wavelength accuracy is .0.03 microns throughout the rocksalt region, and wavelength reproducibility is better than 0.01 microns. The noise level is plus or minus 1 percent and quantitative accuracy is 1 percent. Scattered light is less than 5 percent at 15 microns. There is no loss of wavelength accuracy when multiple curves are recorded on a single sheet of paper. Perkins-Elmer Corp.

Circle E20 green card, last page

Magnetic Shielding—A new 33 page technical brochure entitled Data Sheets 101 (1957) completely describing construction features, performance characteristics and typical applications of non-shock sensitive non-retentive Fernetic and Co-Netic magnetic shielding material has just been released. Included are 12 pages of technical data, 5 pages of performance graphs, 14 pages of illustrations and a handy 2-page comprehensive index. Perfection Mica Co.

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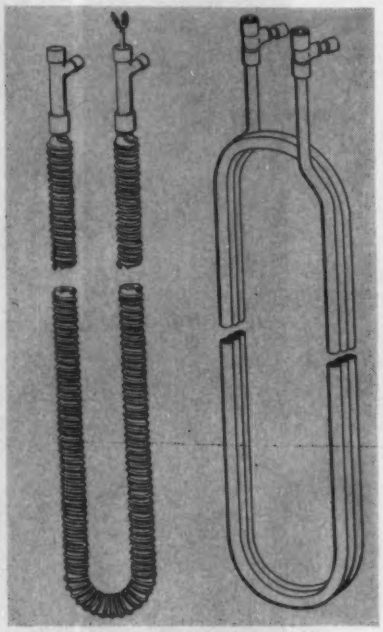

Fractionating Column for Chromatography—Standardized fractionating columns and adsorbents for use in the analysis of gases and liquids by chromatographic methods now are being marketed.

Fractionating columns are available in glass or metal, filled with adsorbent or unfilled, equipped or not with heating coils and with or without thermocouples plus accessory equipment for temperature control. All columns are equipped with quick make-and-break connectors and are easily interchangeable.

Adsorbents are offered in two classifications: solid or surface types for the analysis of gases, and partition types for liquids. Inert powders, properly sized, are available to laboratories interested in preparing their own adsorbents for analysis by partition.

The correct combination of column length and kind of adsorbent to get accuracy and speed, frequently must be determined by trial. The columns and adsorbents, originally designed for chromatographic instruments: The Fracton (illustrated) and The Kromo-Tog, now are offered laboratories for experimentation and as a convenient source of supply when standards have been established. Burrell Corporation.

Circle E22 green card, last page

High Temperature Castable Refractories—A new bulletin containing technical information on high temperature Alundum castable refractories has just been published. Alundum 33-1 castable, previously announced, is a lightweight insulating castable recommended for protection against temperatures up to 3300 F.

Alundum 33-HD castable, a heavy duty castable made up primarily of pure aluminum oxide in dense grain form, is designed for the construction of high temperature furnaces where conditions are severe. Both these castables may be used

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Stabilizer column, 6'6" I.D. x 101' long. Furnished with platforms, rails, flanges and internals.

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Offices in principal cities

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New Equipment . . .

to form intricate shapes quickly and easily. Norton Company.

Circle E23 green card, last page

Microfilm Camera Photographs Both Sides—A new compact, duplex microfilm camera that photographs both sides of a document simultaneously at any of three reduction ratios has just been developed.

The Film-a-Record "Model 11" is a versatile, precision-built microfilm camera, compactly designed, yet incorporating features of cameras many times its size. The unit has a 12-inch throat, and doubles 16 mm. film capacity by filming up one side and down the other using the 8 mm. principle. Readily interchangable lenses are available for 25 to 1, 35 to 1, and 42 to 1 reduction ratios. At the 42 to 1 ratio, the Model 11 films a greater number of documents per roll of film than any other microfilm camera now available.

Full operating controls, warning buzzer and indicator lights assure simple, error-free microfilming with no special operator training needed. Light intensity is adjustable via a single Colorstat control for proper recording of various types and colors of documents.

Film capacity is 250 feet of 16 mm. film, which can be loaded in daylight. Remington Rand.

Circle E24 green card, last page

Large Valves Use Rubber Seats—Huge butterfly valves as large as 44 inches in diameter—capable of controlling the flow of a wide variety of chemicals and hydrocarbons at various temperatures and pressures—have recently been introduced.

Major problem confronted was the development of a resilient seat for sealing. In order for the valve to be dependable, the seat had to resist chemical action as well as the mechanical action when the butterfly deforms the seat under sealing compression.

Hycar American rubber, a versatile raw material proved to be an excellent material for the seats because of its excellent resistance to hydrocarbons, abrasion and temperature.

An installation was made recently at a butadiene plant in South Louisiana. The 44-inch flanged steel butterfly valve is now successfully handling steam and hydrocarbon vapors feeding from a stripped scrubber into an ammonia reboiler at temperatures in excess of 200 F. B. F. Goodrich Chemical Co.

Circle E25 green card, last page

Plastic Pipe and Fittings Data—A new engineering catalog with technical and descriptive data about its plastic pipe, plastic fittings and plastic valves is now generally available.

Written with installations in the process industries in mind, the eight-page catalog includes comprehensive tables detailing both the physical properties and the chemical resistance of the three basic plastic compounds—PVC (Unplasticized, unmodified polyvinyl chloride), Styrene-Copolymer and Buna N (Acrylonitrile-Butadiene). Vanton Pump & Equipment Corp.

Circle E26 green card, last page

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Save on transportation costs, manufacturing time and put yourself in a more competitive position by contacting an experienced "on the spot" source when planning the procurement of process and plant equipment for the West Coast. Send prints for prompt quotation on your next job.

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PS F SINCE 1900

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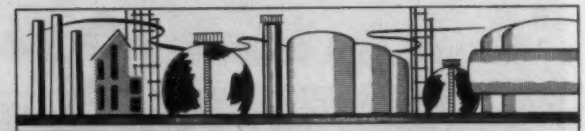

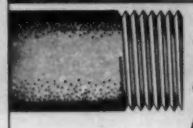

Troubled With High Temperature Threaded Connections?

MOLYKOTE® Type G Lubricant Offers Nearly 100% Safety Against Galling and Seizing

The annual cost of repairs due to galling and seizing of high temperature threaded connections runs into fantastic figures. One oil refinery estimates a yearly expenditure of $60,000 due to this cause. Many of the top refineries are presently using MOLYKOTE, Type G, to practically eliminate these problems.

In test after test, MOLYKOTE has shown the best qualifications as a thread lubricant because it combines these important characteristics:

1. Make-up and break-away torque amazingly reduced.
2. MOLYKOTE, Type G, suitable for high or low temperature threaded connections on bearing surfaces.
3. Galling and seizing practically eliminated.
4. Excellent chemical stability. Resists all but a few strong and concentrated acids.

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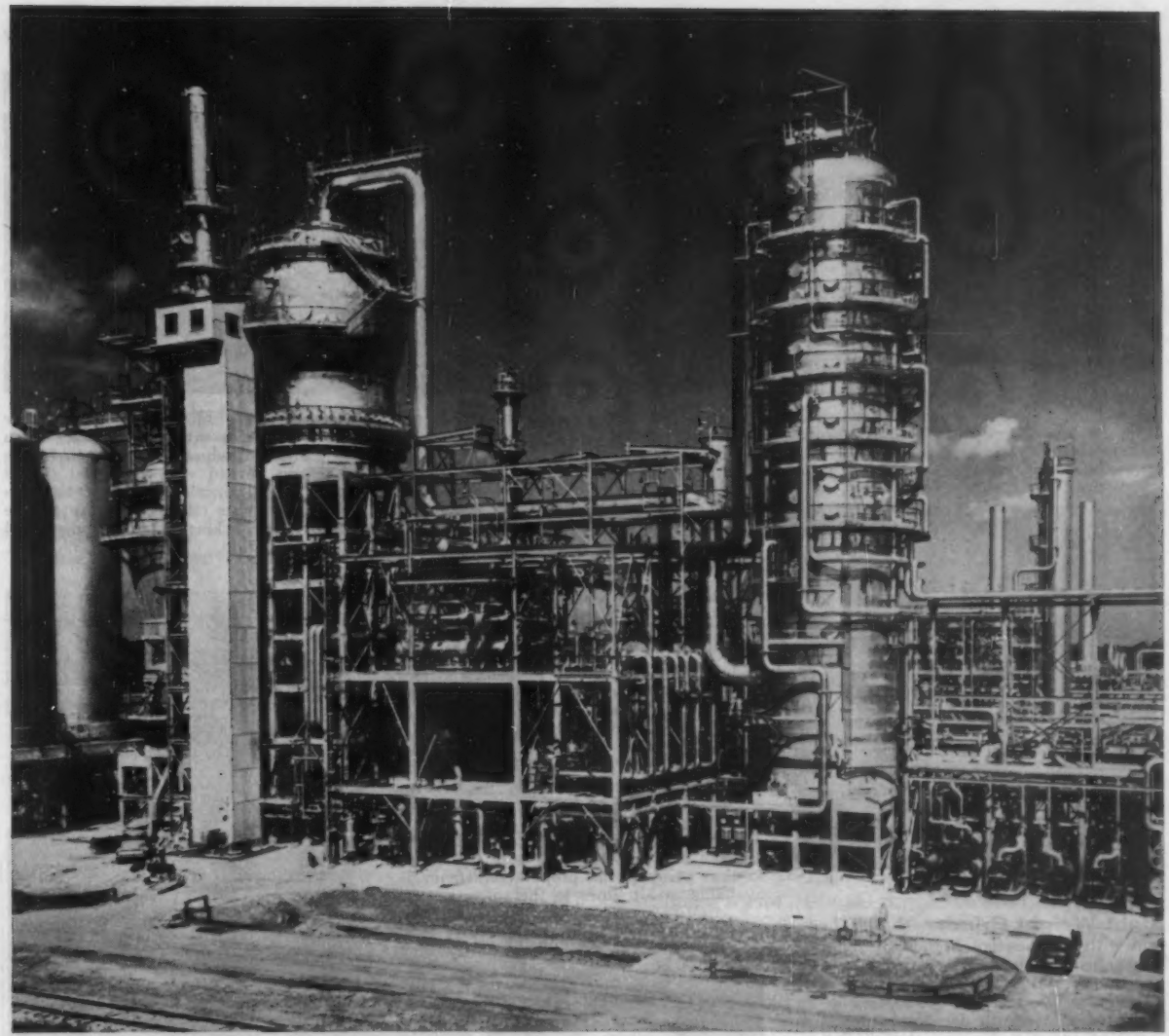

Cat cracking units like this one at Shell Oil Company's Norco, La. Refinery, use industrial concretes made with Lumnite cement to line and insulate the regenerator and stack, line the reactor cone and most of the risers and standpipes.

For better refinery performance . . . industrial concretes made with Atlas LUMNITE*

- Industrial concretes made with Lumnite and suitable aggregates resist heat, resist corrosion, and insulate.
- Production loss due to installation or repairs is minimized because placement is fast and easy. Service strength is reached within 24 hours.
- Service life of installations is extended.

For maximum convenience, use Lumnite-made castables. These are pre-mixed, ready for use, and are made and distributed by leading manufacturers of refractories. For more information, write: Universal Atlas, 100 Park Avenue, New York 17, N. Y.

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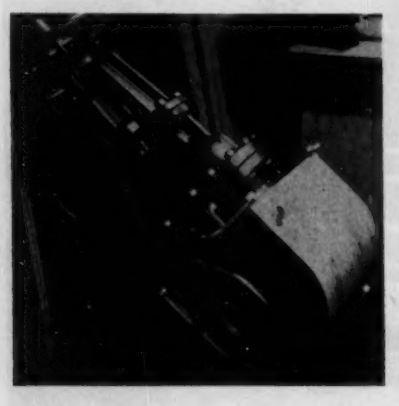
Five latest New Equipment items as selected from the 8th Annual Plant Maintenance Show

Panel Type Valve Warmer—A new valve warmer has just been announced that prevents freezing of the valve mechanism and maintains gum free parts when pumping viscous liquids through the valve. The plate type heat exchanger takes the place of pipe coils, tubing coils or jackets and is fabricated from sheets of embossed metal that form flow channels. The sheets are then seam welded together to form a heat exchanger panel in which steam, liquids or other medium may flow inside the panel channels. It is said to be lower in cost than conventional coils, provides quicker heat transfer, weighs less and is easily installed and cleaned. There are many other applications of this unique heat exchanger device such as the heating or cooling of liquids, slurries, waxes, acids and alkalies. The panels may also be formed into any practical shape or size. Dean Thermo-Panel Coil, Brooklyn, N. Y.



Light Weight Grinder—I. T. Thornson with the Airetool Manufacturing Co., Springfield, Ohio demonstrates their new air motor, Model 700 Grinder. This grinder weighs only 12 pounds. The air operated motor provides ample power at constant speed and won't stall under severe loads or heat up under long, steady use. The housing is cast from aluminum alloy for extra strength and lightness. The grinder is available with a 6 or 8 inch wheel capacity and is operated under a 90 psi working pressure.

Jam-Proof Pipe Threader—Ralph Hamlin of the Ridge Tool Co.'s Philadelphia office demonstrates their new jam-proof, geared, pipe threader. The drive pinion on this threader kicks out automatically making jamming impossible. Therefore, this new advance makes power drive threading safe. Four sets of five special steel dies are held in place by a spring and ball which prevent their falling out. Three thread wipers prevent thread damage from clips. An extra cut-back on the tapered posts relieves pressure on the dies for easy backing-off. The Ridge Tool Co., Elyria, Ohio.

Airless Paint Spray—Eric Nord, president of Bede Products Corp., Amherst, Ohio demonstrates the spray gun technique of the company's airless spray painting system. The heart of the system is a heater which heats the paint in order to lower its viscosity. A hydraulic pump conveys the paint through hose lines to the spray gun where it is atomized by means of the hydraulic pressure. Thus, a heavier application of paint is possible that builds a film faster. Better fan size control with less overspray are also obtained.

The paint is circulated continuously through heater, pump and hose assemblies so that paint of the proper consistency is available at all times to the spray gun.

Corrosive Resistant Coating—R. F. Joscak of the Koppers Co., Inc. New York office exhibits the company's new protective coating called Bituplastic. This coating is applied cold and affords protection to the protected metal for a temperature range of —40 F to 450 F. It is said to be immune from corrosive attack when exposed to petroleum products, heavy chemicals, salt water or heat. The samples exhibited have been immersed in solutions of 50 percent caustic and 50 percent sulfuric acid for approximately three weeks and there is no evidence of corrosion to either the coating or the base metal. This new coating will be in production later this year. Koppers Co., Inc., Tar Products Div., Pittsburgh, Pa.

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Tell us about it.
SK Gear Pumps, product of years of research and engineering experience, are solving problems in almost every industrial field—pumping many types of materials like alcohol, fuel oils, glue, wax, lube oils, resins, cellulose, heated oils, road tars. Some applications require only a top-quality standard pump. Ours are top-quality. Other applications demand something special. If so, we're ready to cooperate.

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Refinery waste disposal problems are quickly and conveniently solved with Bulkley, Dunton Colloidair Separators. These units, designed and engineered to help meet the usual standards established for process flows by government authorities, remove and recover oil, as well as suspended solids, from flows and return effluent for reuse or disposal. They're built for maximum operating efficiency and minimum space requirements.

If you have a pollution or waste recovery problem, a Bulkley, Dunton engineer will be happy to survey your needs and make recommendations. Bulkley, Dunton can also supply a pilot plant for on-the-job tests on your waste flow, if required.

Write today for complete information on Bulkley, Dunton Colloidair Separators or a survey of your disposal problem.

6-248

Bulkley, Dunton Processes, Inc.
295 MADISON AVE., NEW YORK 17, N. Y.

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E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
E13	E14	E15	E16	E17	E18	E19	E20	E21	E22	E23	E24
E25	E26										

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2	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28	9	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
65	66	67	68	68A	68Ba	68Bb	68C	68Da	68Db	68Dc	69	70	71	72	73	74	75	76	77
78	79	80	81	82	83	84	85	86	87	88	89	90	93	94	96	98	99	179	180
181	183	184	185	186	187	188	189	190	193	194	195	196	197	198	199	200	201	202	203
204	205	206	207	208	209	210	211	213	215	216	217	219	220	221	223	224	225	227	228
229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248
249	250	251	252	253	255	256	257	258	259	260	261	262	263	264	265	266	268	269	270
271	272	273	274	275	276	277a	227b	278	279a	279b	279c	280a	280b	280c	281	282a	282b	282c	282d
282e	282f	282g	283a	283b	284	285	286	289	290	291	292	293	294a	294b	295	296	297	298	299
300	301	302a	302b	303	304a	304b	305	306	307a	307b	307c	308	311	312					

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E1 E13 E25	E2 E14 E26	E3 E15	E4 E16	E5 E17	E6 E18	E7 E19	E8 E20	E9 E21	E10 E22	E11 E23	E12 E24

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ADVERTISEMENTS—Circle page number of ad for more products information:

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25	26	27	28	9	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
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271	272	273	274	275	276	277a	227b	278	279a	279b	279c	280a	280b	280c	281	282a	282b	282c	282d
282e	282f	282g	283a	283b	284	285	286	289	290	291	292	293	294a	294b	295	296	297	298	299
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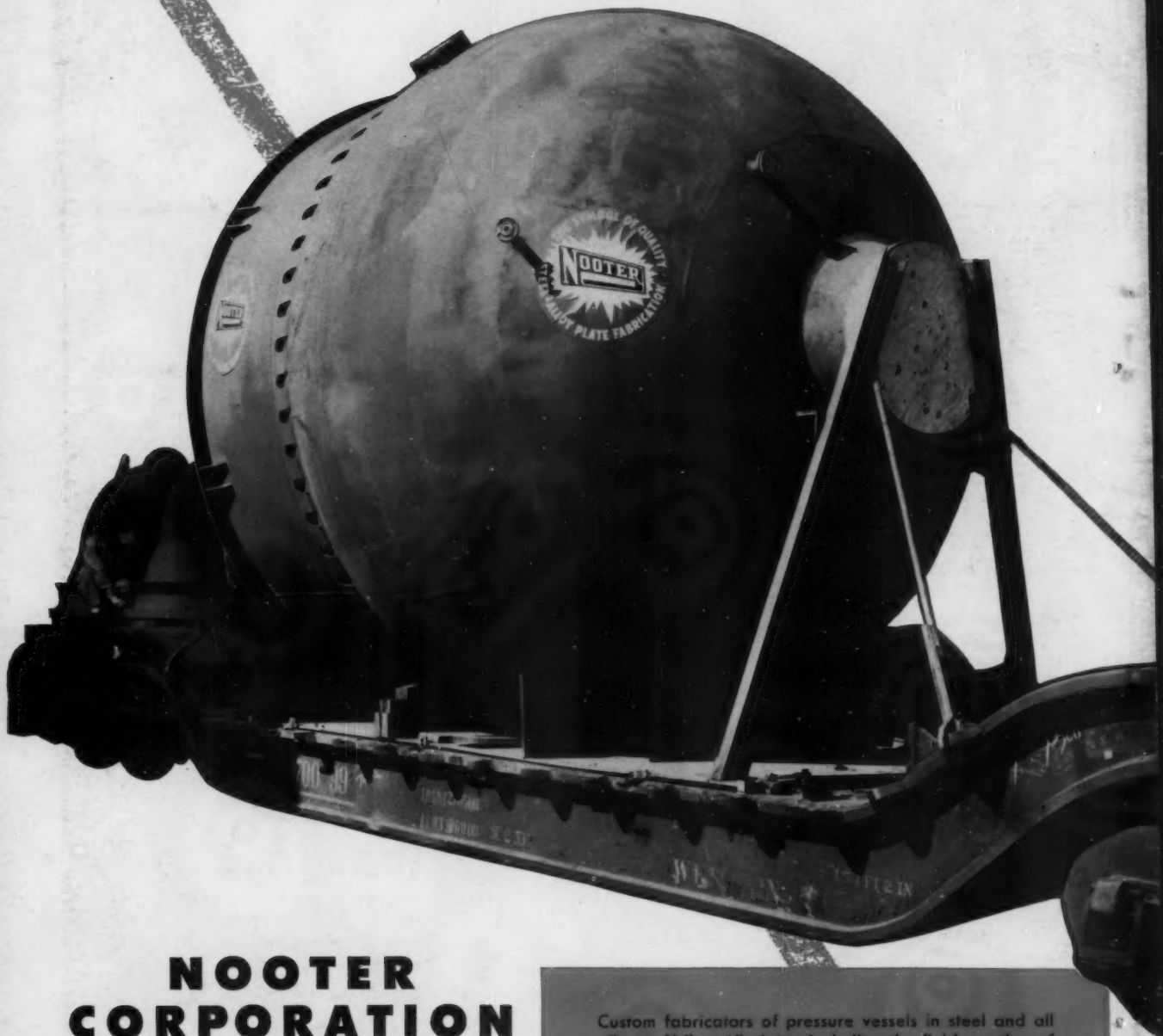

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